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# PHYSICS ABSTRACTS

## SECTION A

*of*

## SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

*Edited and Issued Monthly by*

**THE INSTITUTION OF ELECTRICAL ENGINEERS**

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THE PHYSICAL SOCIETY

THE AMERICAN PHYSICAL SOCIETY

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INSTITUTE OF ELECTRICAL ENGINEERS

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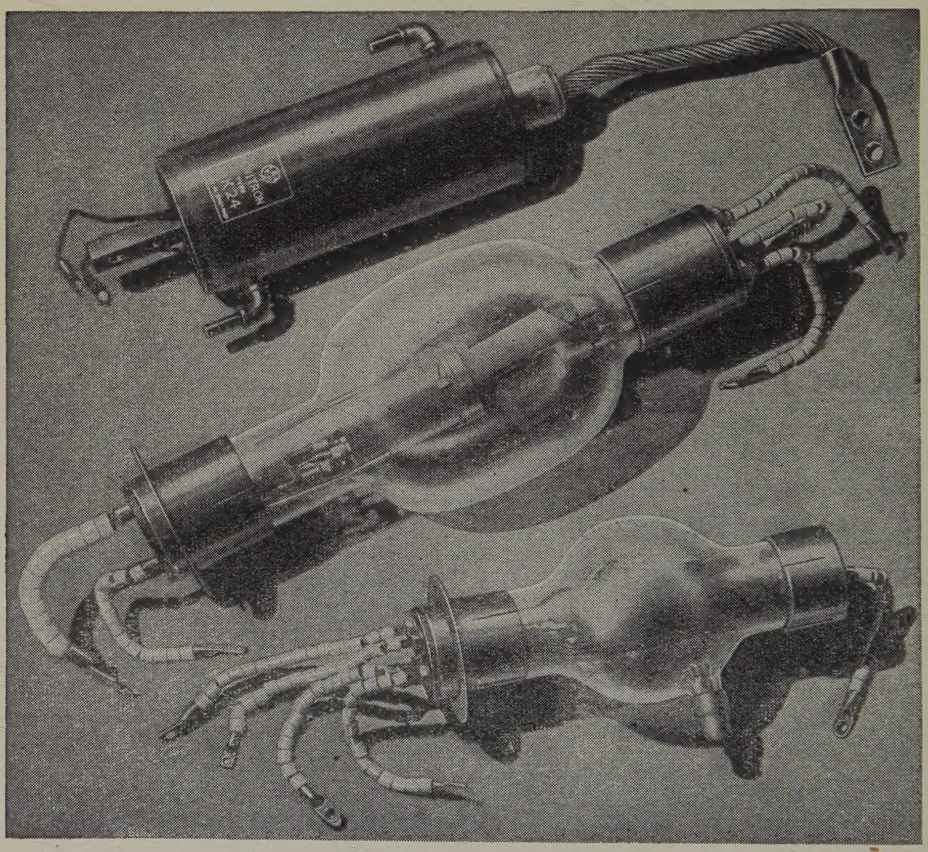
ABSTRACTS 4593–5404

VOLUME 53 **JULY 1950** NUMBER 631

# Valves for Research and Development



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| lectrical and magnetic measurements | Thermionic tubes | Illumination |
| and instruments | Cathode-ray tubes | Metallurgy |
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# LIST OF JOURNALS

The following list supplements that published with the January Number of Vol. 53 (1950). Journa marked * are not received regularly though abstracts of articles from them are occasionally published. T addresses given are believed to be correct, but no responsibility can be accepted for errors.

| | |
|---|---|
| *Ann. Inst. Fourier.* | *Annales de l'Institut Fourier.* [Suite des *Annales de l'Université Grenoble, Section des Sciences Mathématiques et Physique* Institut Fourier, Grenoble. |
| **India Rubb. World.* | *India Rubber World.* [Abstracted by the Research Association British Rubber Manufacturers.] |
| *İstanbul Tek. Üniv. Bül.* | *İstanbul Teknik Üniversitesi Bülteni.* [*Bulletin of the Technical Un versity of Istanbul.*] Yazi Heyeti Sekreterliğine, Gümüşsuy Istanbul. |
| *J. Franklin Inst.* | *Journal of The Franklin Institute.* 20th and The Parkway, Phil delphia 3, Philadelphia. [Correction to list in January number.] |
| *K. Tekn. Högsk. Handl.* | *Kungl. Tekniska Högskolans Handlingar.* [*Transactions of th Royal Institute of Technology.*] *Stockholm.* |
| *Licht-technik* | *Licht-technik.* Helios-Verlag G.m.b.H., Berlin-Borsigwalde. |
| **Mech. World* | *Mechanical World.* [Abstracted by Metropolitan-Vickers Electric Co.] |
| *Publ. Sci. Ass. Océanogr. Phys.* | *Publication Scientifique de l'Association d'Océanographie Physiqu* Union Géodésique et Géophysique Internationale. Det Geofysisk Institutt, Oslo. |
| *Radio-Electronics* | *Radio-Electronics.* [Formerly *Radio-Craft.*] Erie Avenue F to Street, Philadelphia 32, Pennsylvania. |
| **Rep. Nat. Adv. Comm. Aero. Wash.* | *Report of the National Advisory Committee for Aeronautics, Washing ton.* [Abstracted by *Index Aeronauticus.*] |
| *Rev. Elect. Méc.* [*Rev. Alsthom*] | *Revue d'Electricité et de Mécanique.* Société Générale de Con structions Electriques et Mécaniques Alsthom. 38 Avenue Klébe Paris (XVI^e^). |
| **Text. Mfr, Manchr.* | *Textile Manufacturer, Manchester.* [Abstracted by Metropolitan Vickers Electrical Co.] |

## ABSTRACT JOURNAL

| | |
|---|---|
| Coal Utilization Research Association | *Monthly Bulletin of The British Coal Utilization Research Association* 13 Grosvenor Gardens, London, S.W.1. |

## ORIGINAL ARTICLES

It is regretted that the articles from which abstracts are made cannot be sent out on loan. Application should be made to appropriate lending libraries or to the publisher of the Journal concerned; publishers' addresses, where known, are given in the "List of Journals" published with the January Number of Vol. 53 (1950), or in the supplementary lists published subsequently.

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### ERRATA

Abstr. 906, line 3: *for* **20** *read* **26**.
Abstr. 1874, line 5: *for* Y. S. Schuur *read* Ya. S. Shur.
Abstr. 1876, line 4: *for* Y. S. Schuur *read* Ya. S. Shur.
Abstr. 3076, line 3: *for* (*Jan.*, 1949) *read* (*Jan.*, 1950).
Abstr. 3688, lines 6, 15, 17 and 20: *for* $\omega$ *read* w.
Abstr. 4459, line 3: *for* (*Feb.*, 1950) *read* (*Jan.*, 1950).

# *Publications*

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**HANDBOOK OF THE ANNUAL EXHIBITION OF SCIENTIFIC INSTRUMENTS AND APPARATUS**

**METEOROLOGICAL FACTORS IN RADIO-WAVE PROPAGATION**

Report of a Conference held jointly by the Physical Society and the Royal Meteorological Society, 1946.

**REPORT OF INTERNATIONAL CONFERENCE ON FUNDAMENTAL PARTICLES (Vol. I) and LOW TEMPERATURES (Vol. II),** Cambridge, 1946

**THE EMISSION SPECTRA OF THE NIGHT SKY AND AURORAE**

Papers read at an International Conference held under the auspices of the Gassiot Committee, London, July, 1947.

**THE STRENGTH OF SOLIDS**

Report of Conference, Bristol, July, 1947.

**RESONANT ABSORBERS AND REVERBERATION**

Report of the 1947 Summer Symposium of the Acoustics Group of the Physical Society.

**NOISE AND SOUND TRANSMISSION**

Report of the 1948 Summer Symposium of the Acoustics Group of the Physical Society.

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1 Lowther Gardens, Prince Consort Road, London, S.W.7.

# JULY 1950

## MATHEMATICS 51

517.432.1

**593. Heaviside's operational calculus.** B. VAN DER PL. *Instn Elect. Engrs, Paper No.* 958 (1950) 6 *pp.* A historical survey of Heaviside's achievements. A.

517.9 : 621.3.011

**594. A derivation of Heaviside's operational calculus based on the generalized functions of Schwartz.** J. SMITH AND P. L. ALGER. *Trans. Amer. Inst. Elect. Engrs*, **68**, *Pt II*, 939–46 (1949).

The generalized functions of L. Schwartz are used for developing a rigorous mathematical treatment of the intuitive methods of Heaviside. The success of the operational methods depends on the use of two concepts—the Heaviside unit function, and the impulse function and its derivatives which arise when an attempt is made to differentiate the unit function. The latter, however, are not functions in the accepted mathematical sense but, by introducing Schwartz's method and performing the operations in class space, no infinities are met and the results can be expressed on a sound mathematical basis, whilst at the same time the treatment follows closely that of Heaviside. In illustration, the Schwartz method is applied successively to the solution of a 1st, 2nd, *n*th and infinite order differential equation and to a problem where given initial conditions have to be met. H. J. H. STARKS (R)

517.941.9

**595. Upper and lower bounds of eigenvalues for composite-type regions.** E. L. CHU. *J. Appl. Phys.*, **21**, 454–67 (*May*, 1950).

A survey is made to compare the essential features of different variational methods. Schwinger's method is found to have special merits for boundary value and eigenvalue problems concerning composite-type regions. It can give both an upper bound and a lower bound for the eigenvalue of any mode, one bound being as good as the other. It closely resembles the Courant–Trefftz method and is simpler. In both methods the trial functions are so chosen as to satisfy the differential equation while the boundary or continuity conditions are perturbed. The applicability and power of Schwinger's method, being hitherto demonstrated only for particular examples, are exhibited for a whole class of problems by a general formulation of the method in precise terms. The formulation for the upper-bound case presents no difficulty, and a simple proof is given in this paper. A similar proof for the lower-bound case is possible but has a more restricted field of application. The general formulation places the two different cases on equal footing. A way of avoiding the difficulty of having no exact knowledge of the lower eigenfunctions in higher mode cases is discussed. A.

518.5

**596. Magnetic drum storage systems for digital information processing systems.** A. A. COHEN. *Math. Tables Aids Comput.*, **4**, 31–9 (*Jan.*, 1950).

A successful pilot model has been built of proposed memory system, to following standards. 8 tracks per in, 80 digits per in of track, 1 600 in/sec track speed, head clearance 0·002 in, oxide coated drum. Writing rate ca. 500 words/sec, access time 16 msec for 8·5 in dia. drum to store 8 192 words, with digits recorded in parallel. S. MICHAELSON

518.5 : 533.6.011.5

**Graphical, mechanical and electrical aids for compressible fluid flow.** *See Abstr.* 4772

518.5 : 548.734

**The use of "Hollerith" computing equipment in crystal-structure analysis.** *See Abstr.* 5397

518.5 : 621.317.727

**4597. Design and construction of universal function generating potentiometers.** G. A. KORN. *Rev. Sci. Instrum.*, **21**, 77–81 (*Jan.*, 1950).

A new type of potentiometer, whose output voltage may be made $\propto$ a wide variety of functions of the shaft rotation, is described. Voltages corresponding to the desired function values are set up at will at the taps of a linear potentiometer, which then interpolates linearly between these values. A.

518.5 : 621.318.572

**4598. The California Institute of Technology electric analogue computor.** G. D. MCCANN. *Math. Tables Aids Comput.*, **3**, 501–11 (*Oct.*, 1949).

Two basic circuit techniques are employed, (1) a single independent variable represented continuously as time, and (2) discrete values of several independent variables represented in suitable form for the application of finite difference methods. The present facilities offered by the equipment are summarized, and examples are given of the framing of problems in analogue form. Two types of function generator are briefly described; one employing Ge diodes, and the other a c.r.o. with photoelectric "feedback." Its field of application is reviewed. A. J. KENNEDY

518.5 : 621.318.572

**4599. An electronic circuit which extracts antilogarithms directly.** F. C. SNOWDEN AND H. T. PAGE. *Rev. Sci. Instrum.*, **21**, 179–81 (*Feb.*, 1950).

A 6SK7 variable-$\mu$ tube was used as an inverted triode, i.e. the plate was used as the controlling, and the control grid as the output element. A.

518.5 : 621.318.572 : 621–526

**4600. Analog computers for servo problems.** D. MCDONALD. *Rev. Sci. Instrum.*, **21**, 154–7 (*Feb.*, 1950).

Important simplifications can be made in the design of operational amplifiers used in analogue computers when they are applied to servomechanism problems, as the dynamic response accuracy of the computer can be made quite high enough for comparatively low values of the amplifier gain. The exact equations for operational amplifiers are derived, and appropriate approximations applied to them for the above purpose.

518.5 : 621.392.5 : 621.318.572

**4601. Solution of partial differential equations with a resistance network analogue.** G. LIEBMANN. *Brit. J. Appl. Phys.*, **1**, 92–103 (*April*, 1950).

It is shown that resistance networks are capable of

very high accuracy in the solution of partial differential equations with given boundary conditions as the networks possess certain averaging properties. Fairly exhaustive tests gave accuracies in the range of 1 part in 1 000 to 1 part in 10 000. The design of the network used is described; it is of the axially symmetrical type, with 60 meshes in the $z$-direction and 20 meshes in the $r$-direction, and is surrounded by a termination strip. 50 current feeding points for adjusting boundary conditions are provided. The boundaries of the models need not coincide with the mesh points as correction can be made by local modifications of the network. It is also possible to take measurements within a mesh of the network and to simulate the introduction of dielectric material into an electric field. The high accuracy, and simplicity and speed of operation, make the resistance network a useful tool in the investigation of field distributions in many branches of science and engineering. A.

519.1

**4602. (i) A problem in combinatorial analysis and probability theory. (ii) A test for the reality of cyclic variations.** W. GLEISSBERG. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **10**, 25–42 (*Jan.–Oct.*, 1945) *In German.*

(i) A recurrence relation is found for the probability $W(s, k)$ that one arrangement, chosen at random from all the permutations of $s$ different numbers, will contain more than $k$ extrema. *Table*; $W(s, k)$, $s = 4(1)25$, $k = 0(1)s–2$, $2d$. (ii) A test for the reality of a cyclic variation in a series of observations is based on this. The test is extended to the case where the numbers observed are not all different. An example is given. S. MICHAELSON

519

**4603. Tests for random ordering of errors.** W. GLEISSBERG. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, 1 107–26 (*April*, 1947). Also *Publ. Istanbul Univ. Ob* (*No.* 31) 107–26 (1947) *In German.*

If each term of a sequence of numbers is equall likely to be +ve or −ve, the average length of a ru of numbers having the same sign depends on th length of the sequence. A formula is given for th average. This can be used to test whether th differences between a series of predicted and observe values are due to chance errors. It yields a necessar but not sufficient condition. S. MICHAELSO

519.21 : 621.395.7

**4604. On the application of the theory of function to the calculation of certain continued probabilitie used in the theory of telephone networks.** F. POLLACZEK *Ann. Inst. Poincaré*, **10** (*No.* 1) 1–55 (1946) *In Frenc*

The treatment is quite different from that adopte by Erlang. Any number of calls $n$, with $n$ duration and $n$ times of initiation can be treated, in principl similarly to classical problems in continued proba bilities, involving real functions of $(2n - 1)$ variables The method is complicated but a solution is possibl by means of complex analysis, together with generalization due to Dirichlet. The results ar more convenient to handle and are more flexibl than the Erlang formulations. The simple problem of 1 outlet and 2 calls is treated and extended to outlets and $n$ calls each of duration $t$. The cas $n \to \infty$ is shown to be equivalent to the "statistica equilibrium" of Erlang, and other special case follow equally simply. The method is applied t the problem in which $t$ has only 2 possible values $h$ or $2h$, of probabilities $a$ and $b$ $(= 1 - a)$. The mathematical analysis is detailed. A. J. KENNEDY (R

# ASTRONOMY . ASTROPHYSICS . GEODESY 52

521.1 : 531.51

**4605. The evolution of dense gravitating systems and the generation of celestial bodies.** L. E. GUREVICH. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 6) 981–4 (1950) *In Russian.*

521.11

**4606. The evolution of systems of gravitating bodies.** L. E. GUREVICH AND B. YU. LEVIN. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 5) 781–4 (1950) *In Russian.*

521.12

**4607. On Kowalsky's formulae for binary orbits.** D. BELORIZKY. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 5) 596–9 (1949).

521.2

**4608. On the cause of the equatorial acceleration of the sun.** V. V. RADZIEVSKIĬ. *Dokl. Akad. Nauk, SSSR*, **67** (*No.* 5) 807–10 (1949) *In Russian.*

521.6

**4609. On a necessary condition for the transformation into satellites of the planet of bodies projected from a planet.** C. IACOB. *Gaz. Mat., Bucureşti*, **54**, 192–201 (1949) *In Rumanian.*

522.47 : 535.312.5

**4610. On the realization of a floating reflector.** J. F. COX AND O. GOCHE. *Bull. Acad. Roy. Belg Cl. Sci.*, **35** (*No.* 12) 1111–12 (1949) *In French.*

Describes a method of depositing thin metallic films on certain liquids to form a reflecting pellicule Deposition is by electric discharge under low pressure The method is suggested for the production o reflecting surfaces for nadir observations and fo photographic zenith telescopes. E. G. MARTIN

522.6 : 621.38

**4611. The automatic guiding of astronomica telescopes.** T. G. THORNE. *Engineering*, **169**, 197–20 (*Feb.* 24, 1950).

Incident starlight passing through a suitably designed light-chopper falls upon a photomultiplie tube; the depth of the frequency-modulation of th square-waveform output is $\propto$ the radial misalign ment, the phase of the modulation being determine by the angular direction of the error. The productio of a d.c. error signal from this output and the separa tion of the components of the error in R.A. and De is described. Results with the Greenwich 13-i astrographic telescope were satisfactory provided tha a star of sufficient brightness for the shot-noise of th photocell to be negligible was available. It is sug

sted that flexural difficulties with large telescopes ight be overcome by driving the plateholder.
M. W. OVENDEN

523.12

12. **Cosmology and the origin of stars.** P. JORDAN. v. *Geofis.*, **8**, 14–33 (*Jan.–March*, 1949) *In Spanish.* Restatement of results in Abstr. 654 (1950) and 77 (1948). R. A. NEWING

523.12

13. **The cosmic time scale.** L. GIALANELLA. *ientia*, **85** (*No.* 1) 1–7 (1950) *In Italian.* Reviews evidence in favour of the short time scale.
R. A. NEWING

523.165

14. **Concerning the source of galactic radio noise.** E. WILLIAMSON. *J. Roy. Astr. Soc. Can.*, **44**, –16 (*Jan.–Feb.*, 1950).
If the sun is at or near the median plane of the laxy, idealized as a homogeneous isothermal nitting slab of indefinite extent, then the total pacity $2\tau_\nu$ in the $z$-direction at frequency $\nu$ and the gle $\theta_{\frac{1}{2}}(\nu)$ between the two galactic latitudes where e intensity is half of maximum are related by $\frac{1}{2}\theta_{\frac{1}{2}}(\nu) = \tau_\nu/\log_e 2$. Since $\theta_{\frac{1}{2}}(\nu)$ is known from servation without requiring the (uncertain) absolute libration of the receiver, $\tau$ may be determined as $\nu$). Published observations over the frequency nge 20·5–480 Mc/s define an empirical relation-ip $\tau \propto \nu^{-0\cdot7}$ whereas the hypothesis of free-free ansitions leads to $\tau \propto \nu^{-2}$. M. W. OVENDEN

523.165

15. **Origin of the fluctuations in the intensity of dio waves from galactic sources.** F. G. SMITH, G. LITTLE AND A. C. B. LOVELL. *Nature, Lond.*, 5, 422–4 (*March* 18, 1950).
Observations of the Cygnus and Cassiopeia sources 3·7 m by two receivers separated by 210 km owed no mutual correlation of fluctuations, though the degree of disturbance at any given time as usually similar. On 6·7 m with a variable base-ne, no correlation was found for separations 20 km; on 3·7 m complete correlation exists for parations 100 m, and partial correlation for a paration of 3·9 km. An atmospheric origin is us indicated. Localized ionospheric regions with ffering ionization densities and gradients may use phase reversals of appreciable fractions of dividual Fresnel zones, but such a diffraction echanism is in apparent contradiction to the sence of correlation between the amount of ctuation and other ionospheric disturbances, and e fact that considerable correlation of individual ctuations on different wavelengths exists. A rare, aracteristic short-duration burst is a type of ctuation which shows correlation over large stances, and may be intrinsic to the sources.
M. W. OVENDEN

523.165

16. **Point sources of radio noise.** D. H. MENZEL ND D. J. CROWLEY. Letter in *Nature, Lond.*, **165**, 3 (*March* 18, 1950).
It is suggested that giant comets with distant helia absorb extreme ultraviolet and X-ray solar diation, which is converted by plasma-type oscillations into r.f. radiation emitted over a 1 000 Mc/s band. Such an origin for the radio sources would require that they have annual parallaxes of the order of 1°. M. W. OVENDEN

523.2

4617. **Further studies on the origin of the solar system.** D. TER HAAR. *Astrophys. J.*, **111**, 179–90 (*Jan.*, 1950).
Supplement to Abstr. 3673 (1949). The physical conditions in a gaseous disc around the sun, out of which the planetary system might have been formed, are considered, and the consequences of these conditions are studied. A.

523.32

4618. **Theoretical photometry of the moon.** H. F. A. TSCHUNKO. *Z. Astrophys.*, **26** (*No.* 2–3) 279–94 (1949) *In German.*
Rediscussion of Bennett's determination of photovisual magnitudes for 59 selected regions of the moon's surface, observed under 11 different phase angles [*Astrophys. J.*, **88**, 1 (1938)], and of Minnaert's and Wesselink's theoretical considerations [Abstr. 1476 (1941) and *Bull. Astr. Ned.*, *No.* 390 (1948)]. Modifications of the reflection laws are suggested, and conclusions drawn as to the structural nature of essential surface formations; the existence of an extensive gravel layer appears indicated. A. BEER

523.43

4619. **Some aspects of the meteorology of Mars.** S. L. HESS. *J. Met.*, **7**, 1–13 (*Feb.*, 1950).
A vertical structure of the Martian atmosphere based on radiative equilibrium in the stratosphere and near convective equilibrium in the troposphere is derived. The surface temperature and circulation pattern are discussed.

523.5 : 521.2

4620. **The Poynting–Robertson effect on meteor orbits.** S. P. WYATT, JR. AND F. L. WHIPPLE. *Astrophys. J.*, **111**, 134–41 (*Jan.*, 1950).
Tables are given to enable simple calculation of the times of fall in terms of the initial orbital elements, $q$ and $e$, and particle radius and density. Total times of collapse are computed for several meteor showers. Since there is a linear dependence of the time on particle radius, the material in showers should ultimately be dispersed so that larger particles move with greater orbital $a$ and $e$ than do the smaller ones. This leads to the possibility of observing the Poynting–Robertson effect in a given swarm by a correlation of the observed mean magnitude of meteors with the time while the earth transits the shower. Such a correlation is not detected for any shower definitively: an upper limit, therefore, is set for the age of showers, ranging from $5\times10^6$ yr for some to $< 10^5$ yr for the Geminids. If some sporadic meteors had a common origin with the meteorites and asteroids, the operation of the Poynting–Robertson force requires that, for times of origin longer ago than the $60\times10^6$ yr suggested by Bauer, all material of radius $< 0\cdot08$ cm has been swept into the sun. Therefore, virtually no sporadic meteors fainter than the 5th magnitude can be arriving now on the earth unless they are cometary or interstellar in origin. For a time of $3\times10^9$ yr the minimum radius is about 4 cm. The tables given for computation of the times of orbital

contraction are valid for any radiating body of known mass and radiation by means of a simple correction. The process of contraction is faster by a factor of about 100 000 for *B* stars than for the sun. But, conversely, the Poynting–Robertson effect due to the general radiation of a galaxy is entirely too small to affect appreciably the dynamics of interstellar dust. A.

523.51

**4621. Microhardness testing of iron meteorites.** F. K. DALTON. *J. Roy. Astr. Soc. Can.*, **44**, 1–11 (*Jan.–Feb.*, 1950).

523.51

**4622. Geological age of meteorites.** F. A. PANETH. Letter in *Nature, Lond.*, **165**, 454 (*March* 18, 1950).

523.531

**4623. A photographic study of the Draconid meteor shower of 1946.** L. G. JACCHIA, Z. KOPAL AND P. M. MILLMAN. *Astrophys. J.*, **111**, 104–33 (*Jan.*, 1950).

A discussion of 204 Draconid (Giacobinid) meteors photographed at North Bay, Ontario, Canada, during the night of October 9–10, 1946. The fundamental data pertaining to each individual meteor are assembled. The cosmic spread of the radiant turns out to be 6°·2, more than half of which is probably due to observational errors. This is much less than the spread of any of the other major showers investigated so far and, together with the fact that no Draconid meteors are observed except in the immediate neighbourhood of the parent-comet, points to a relatively early stage of disintegration of the swarm. The visual paths of the Draconid meteors proved to be of considerably shorter duration than those of most normal meteors and, considering their low geocentric velocity, were visible at abnormally great heights (between 90 and 98 km, on the average). The observed decelerations would point to masses which are, on the average, one hundred times < those of other meteors of comparable brightness and geocentric velocity. All this indicates that the Draconid meteors are probably composed of "soft" material, which is more easily vaporized by friction in the earth's atmosphere than that of other meteor particles. A.

523.58

**4624. The velocities and heights of meteors.** B. J. LEVIN. *Astr. J., USSR*, **26** (*No.* 2) 115 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 47) (1950).

A statistical study of 384 meteors for which data had been published by the British Astronomical Association. A study of systematic errors reveals that Porter's velocities for fast meteors are much too low, while for slow meteors the data are probably unaffected by serious errors. A table gives the distribution of meteors according to the elongations of their radiants from the apex. The author concludes that the number of meteors with direct orbits is several hundred times > that with retrograde orbits. Finally, he discusses the heights at disappearance and finds no indication of a lower maximum at $H \sim 40$ km, which had been previously considered as well established. Apparently there exists no minimum at $H \sim 60$ km, which Lindemann and Dobson had derived from the catalogue by Denning.

523

**4625. On the pressure of light upon the molecu in the atmospheres of comets.** S. M. POLOSKO *Astr. J., USSR*, **26** (*No.* 4) 260 (1949) *In Russi* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* (1950).

523.

**4626. The spectrum of comet 1948l.** P. D. Jc AND P. SWINGS. *Astrophys. J.*, **111**, 41–9 (*Jan.*, 195

523

**4627. The sun's general magnetic field.** P. SWEET. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 507–16 (1949).

The effects of large-scale convection currents a differential angular velocity on the sun's gene magnetic field are studied in detail. Cowling theorem on the dynamo action of convection curre is extended to the case where a small external ma netic field is produced in the convection curre themselves. It is shown that a general magnificati of the external field would only be possible if t Hall current were sufficiently large. In the sun t field so produced would be negligible. Ferrar work on the effect of differential angular velocity the field is extended to allow for the Hall effect. It confirmed that the observed differential angul velocity is incompatible with the existence of a stea general magnetic field in the solar atmosphere.

523.7 : 537.591

**Magnetic field of the sun.** *See Abstr.* 5095

523.7

**4628. On the photovisual magnitudes of Sirius a the sun.** G. DE VAUCOULEURS. *Ann. Astrophys.*, 1 287–90 (*Oct.–Dec.*, 1949) *In French.*

Eight series of observations of Sirius made betwe 1836 and 1935 are discussed, a photovisual magnitu of $-1{\cdot}37 \pm 0{\cdot}02$ being obtained. Woolley an Gascoigne's measures of the ratio of the sola intensity to that of Sirius at various wavelength [Abstr. 4410 (1949)] are interpolated to the mea wavelength of the photovisual system (5 430 Å The combination of these results yields the correcte photovisual magnitude of the sun, $-26{\cdot}91 \pm 0{\cdot}04$. M. W. OVENDE

523.7

**4629. The solar constant.** K. WEGENER. *Geofis Pura Appl.*, **15**, 186–9 (*Oct.–Dec.*, 1949) *In Spanish.*

The author discusses the discrepancy between th commonly accepted value of 1·94 for the sola constant and the value of 2·4 which he derives fro the sun's surface temperature and its distance fro the earth. E. M. FOURNIER D'ALB

523.74

**4630. On the origin of sunspots.** N. GÖKDOĞA *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **13**, 240– (*Oct.*, 1948). Also *Publ. Istanbul Univ. Obs.* (*No.* 33 240–2 (1948)

From hydrodynamical consideration, and the basi assumption that one component only of the sola rotation, a differential rotational velocity o $0{\cdot}028 \sin^2 \phi$ ($\phi$ is the heliographic latitude), is effectiv in spot formation, it is shown that (i) the condition are satisfied only within the latitude zone $+55°$–$0 - 55°$, and (ii) the velocity gradient pe

endicular to the flow has maximum value within ne relatively narrow belt of width, ± 28°. In ractice, few spots are observed outside the zone = 40° latitude, and at sunspot maximum spots ppear most frequently around ± 10°. This is xplained by taking into account the depth of the ot disturbance, and the existence of meridional urrents beneath the photosphere. The latter tend to ause spots to appear at a latitude ~ 18° lower than at of their birth. D. R. BARBER

523.746

**631. Formulae for sunspot prediction.** W. GLEISSERG. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **14**, 8–110 (*April*, 1949). Also *Istanbul Univ. Obs. Yaz. No.* 36) 98–110 (1949) *In German.*

Based on the author's probability method [Abstr. 894 (1949)] formulae are derived to predict the ssential features of sunspot cycles, with probabili- es of 0·90 and 0·95 respectively. Predictions efer to the cycle immediately following the last f 3 consecutive cycles which provide critical data to valuate the requisite parameters. D. R. BARBER

523.746

**632. Statistical investigation of the daily variation in the magnetic field strength in sunspots.** W. GROTRIAN AND H. KÜNZEL. *Z. Astrophys.*, **26** (*No.* 2–3) 325–33 (1949) *In German.*

Utilizing the Mount Wilson material over the eriod 1917–24, the frequency distribution of the aily variations is derived. An attempt to fit a Gaussian distribution is not successful. It is, however, ossible to explain the observational curve by the uperposition of 2 independent distribution types of ean daily variations, namely, of 230 and 500 gauss, espectively. The first type may be caused by omparatively inactive spots, see Brunnckow and Grotrian [Abstr. 3707 (1950)], and the second one y less stable spots. A. BEER

523.752 : 537.56

**633. Ionization and excitation in the solar prominences.** K. WURM. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 39–48 (1948) *In German.*

The structure of the solar prominences is analysed ith respect to their ionization- and excitation- onditions. The usual application of the Saha- and oltzmann-Equation is avoided in view of indicated eviations from thermodynamical equilibrium. The ollowing quantities are derived: electron-density, otal density, degree of the ionization of the H-atom, lectron temperature. The Balmer-terms $n = 2$, $= 3$ are studied. A method for the determination f the intensity of the Lyman α-radiation is discussed. A. BEER

523.755

**634. Photometry of a part of the solar corona during the total eclipse on 9th July 1945.** G. ÄRNEFELT, H. A. ALIKOSKI AND P. KUSTAANHEIMO. *nn. Acad. Sci. Fennicae, Ser. A*1 (*No.* 48) 44 *pp.* 949).

Two photographs, corresponding to wavelengths of 000–5 600 Å and 6 000–6 400 Å, yielded relative tensities. Comparison of equatorial intensities with ose of Öhman [Abstr. 2008 (1947)] enable absolute tensities to be deduced, thus extending Öhman's sults. M. W. OVENDEN

523.76

**4635. On the abundance of $C^{13}$ in the solar atmosphere.** J. L. GREENSTEIN, R. S. RICHARDSON AND M. SCHWARZSCHILD. *Publ. Astr. Soc. Pacif.*, **62**, 15–18 (*Feb.*, 1950).

Laboratory spectra of King and Birge [*Astrophys. J.*, **72**, 19 (1930)] show that two doublets of the isotope bands $C^{13}N^{14}$ corresponding to the strong solar $C^{12}N^{14}$ band at λ3883 fall at λ3874·34 and λ3874·92. There is little blending in the solar spectrum at these wavelengths, and from the absence of any corresponding solar absorption an upper limit to the abundance ratio of 1/36 is deduced, using the empirical curve of growth of Pierce and Goldberg [*Obs. Univ. Michigan, Tech. Rep., No.* 1]. The C–N cycle indicates a C-isotope abundance ratio of 1/5 for the solar core; either considerable errors exist in the experimentally-determined cross-sections, or little mixing between core and atmosphere occurs in the sun. M. W. OVENDEN

523.77

**4636. On the calculation of the intensity distribution in Fraunhofer lines.** A. UNSÖLD AND W. KURZ. *Z. Astrophys.*, **26** (*No.* 2–3) 200–4 (1949) *In German.*

The weight functions employed for the calculation of the Fraunhofer lines are exactly determined under the assumption that for continuous absorption the Kirchhoff-Planck function $E(\tau)$ is given as a power series of the optical depth $\tau$. Good agreement is found with previous calculations by Minnaert [*Z. Astrophys.*, **12**, 313 (1936)]. A new and simple formula for estimating with good approximation the higher exponential integrals $K_n(\tau)$, for not too large $n$ and $\tau$, is evaluated: $K_n(e\tau) = e^{-\tau\sqrt{3}/3(n-2)/2}$. A. BEER

523.77

**4637. Measurement of total absorptions of faint Fraunhofer lines with the method of effective line widths.** F. W. JÄGER. *Z. Astrophys.*, **26** (*No.* 2–3) 341–73 (1949) *In German.*

A method is developed which is based on Öhman's original use of a wide slit [*Medd. Astr. Obs. Upsala* (*No.* 33) (1927)]; see also Siedentopf [*Astr. Nach.*, **254**, 3 (1935)]. Jäger makes the slit-width variable and thus keeps the amount of light received by the photocell of the photometer constant. Each line is then characterized by its own "effective line-width." Theoretical discussion as well as the practical application to sun spectra of high dispersion (obtained with the new Göttingen Tower Telescope) show that the labour involved in the new method is considerably reduced, while the previously attained accuracy is at least maintained. A. BEER

523.78

**4638. The illumination from the solar crescent near totality of the eclipse of May 20, 1947.** R. A. RICHARDSON AND E. O. HULBURT. *Astrophys. J.*, **111**, 99–103 (*Jan.*, 1950).

With a recording photocell of photopic spectral sensitivity, 11 measurements were made of the illumination from the solar crescent during the exposed outer 1/100th of the solar radius. From these the radial variation of emission near the edge of the solar disc was found to be approximately linear, decreasing from 0·48 to 0·36 at 99·0–99·9% of the radius, with a slight trace of a shelf at about 99·6%. A.

523.802

**4639. The distribution of stars in galactic longitude.** Sh. T. Khabibullin. *Astr. J., USSR*, **26** (*No.* 4) 223 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 47).

523.82

**4640. Photoelectric studies. I. Color-luminosity array for members of the Hyades cluster.** O. J. Eggen. *Astrophys. J.*, **111**, 65–80 (*Jan.*, 1950).

523.82

**4641. Photoelectric studies. II. Color-luminosity array for members of the Pleiades cluster.** O. J. Eggen. *Astrophys. J.*, **111**, 81–98 (*Jan.*, 1950).

523.82

**4642. The photovisual flux of stars.** N. Milford. *C.R. Acad. Sci., Paris*, **230**, 820–1 (*Feb.* 27, 1950) *In French.*

523.821

**4643. A method for the determination of stellar magnitudes and colours.** B. Westerlund. *Ark. Astr.*, **1**, *Paper* 9, 91–9 (1949).

Objective-grating spectra with a Schmidt-telescope, using a special plate (Eastman 103 a-E) whose spectral sensitivity curve shows two well-defined maxima are examined with a recording microphotometer. Magnitudes may be determined in 3 colour ranges from a single exposure with an accuracy equivalent to that usually obtained in single-colour determinations.

M. W. Ovenden

523.83

**4644. On a proposal to use the extragalactic nebulae in measuring the proper motions of stars, and in evaluating the precessional constant.** W. H. Wright. *Proc. Amer. Phil. Soc.*, **94** (*No.* 1) 1–12 (1950).

523.841

**4645. The luminosity-velocity relation for pulsating stars.** E. A. Milne. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 5) 517–27 (1949).

523.841.37

**4646. Pulsation of Cepheids II.** L. E. Gurevitch and S. I. Lebedinsky. *Astr. J., USSR*, **26** (*No.* 3) 138 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 46).

523.841.9

**4647. Velocity variation from λ4481 of MgII in *V*367 Cygni.** R. F. Sanford. *Publ. Astr. Soc. Pacific*, **62**, 21–2 (*Feb.*, 1950).

Nine coudé spectrograms (Mount Wilson) of this eclipsing variable yield velocity curves from sharp lines, and from the diffuse Mg II line. The two curves are in phase, but the latter has a much larger amplitude. The observations are compared with those of Christie [Mt. Wilson Contr., No. 475; *Astrophys. J.*, **78**, 200 (1933)], and it is questioned whether the variation is strictly periodic. M. W. Ovenden

523.842

**4648. Statistics of the physical characteristics of binaries and the hypothesis of capture.** B. Yu. Levin. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 17–20 (1950).

523.842.3

**4649. Spectroscopic binaries. (George Darwin Lecture).** O. Struve. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 5) 487–506 (1949).

A survey is given of the observations of inconsistencies between the photometric and velocity curves of spectroscopic binaries of period 2–7 d, and their interpretation in terms of gaseous streams and rings surrounding one of the components. The systems of *U* Cephei and *U* Sagittae are considered in detail. The known properties of these streams, which it is believed are possessed by all close binary systems are summarized, and their possible evolutionary significance discussed. M. W. Ovenden

523.8

**4650. On the dynamics of nonstationary star systems.** R. Kurth. *Z. Astrophys.*, **26** (*No.* 2–3) 168–75 (1949) *In German.*

Such a system to which a space-time transformation co-ordinates a stationary one [see Schürer, *Astr. Nachr.* **273**, 230 (1943) and Chandrasekhar, *Principles of Stellar Dynamics*] must have a constant density. A method is here developed which derives the distribution function from the density, assuming a known ellipsoidal velocity distribution. Applications are made to two special nonstationary systems: the one is characterized by a spherical velocity distribution, the other by spherical-symmetrical structure. In both cases the density is found to be zero. The implications of the contradictory results involved are discussed. A. Beer

523.85

**4651. The determination of stellar space densities in a spheroidal cluster.** P. N. Kholopov. *Astr. J., USSR*, **26** (*No.* 2) 110 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 46).

523.85

**4652. Absorption of light and the diameters of open star clusters.** K. A. Barkhatova. *Astr. J., USSR*, **26** (*No.* 4) 251 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 47) (1950).

523.851

**4653. The motions of open star clusters.** K. A. Barkhatova. *Astr. J., USSR*, **26** (*No.* 4) 256 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 47).

523.851

**4654. On a theorem in the dynamics of stellar systems.** B. Lindblad. *Stockholms Obs. Ann.*, **16** (*No.* 1) 1–34 (1950).

The variation of potential due to condensations and rarefactions of matter in a rotating "quasi-spheroidal" stellar system causes certain disturbances in the relative orbit of a particle in a rotating co-ordinate system. The disturbances in the relative velocities correspond to a certain relation between density and velocity dispersion which resembles the relation between density and velocity dispersion in the case of an adiabatic change in a monatomic gas. On the basis of this theorem the mass motions in a rotating stellar system are made the subject of a renewed discussion. The dynamical theory of the barred spiral nebulae is fully discussed, with corroboration of earlier results, and the theory of the ordinary spiral nebulae is briefly summarized. A.

523.852.3

**4655. Galactic and extragalactic studies, XX. On the distribution of 78 000 of the brighter northern galaxies.** H. Shapley. *Proc. Nat. Acad. Sci., Wash.*, **36**, 157–66 (*March*, 1950).

523.854

**4656. Structure of the galaxy and the sense of rotation of spiral nebulae.** J. G. BOLTON AND K. C. WESTFOLD. Letter in *Nature, Lond.*, **165**, 487–8 (*March* 25, 1950).

If the size of external galaxies increases with increasing spiral structure, as suggested by Hubble, the large dimensions of our galaxy may be taken as an indication of pronounced spiral structure. On the assumption that the intensity of radio-frequency radiation in a given direction indicates the extent of material in that direction, available surveys of galactic noise suggest the existence of spiral structure with an arm opening out in the direction of Cygnus, a conclusion with which optical star-counts are consistent. From the direction of rotation deduced from stellar and stellar cluster motions, the sense of rotation of the galaxy is found to be that of an unwinding spiral.

M. W. OVENDEN

523.854 : 537.591

**4657. On the origin of the radiowave- and the cosmic ray-radiation in the Milky Way.** A. UNSÖLD. *Z. Astrophys.*, **26** (*No.* 2–3) 176–99 (1949) *In German.*

A comprehensive and critical account of the recent progress in the radio research on sun and Milky Way. The general view, that the origin of the stellar radio waves can be traced to free-free electron transitions in the interstellar gas, is contradicted and a revised theory developed. In analogy to the observations of the radio emission coming from the disturbed sun, an enormously increased activity of certain types of stars is suggested. (The ratio of radio-emission to visual radiation is for some Milky Way regions $> 10^{13}$ times the average value for the sun.) Furthermore, since solar flares are also known to have been responsible for observed intensity increases in cosmic rays, it is now suggested that these may be attributed to much more intense stellar activity, e.g. to induction effects of variable magnetic fields in the outermost layers of particular types of stars. A. BEER

523.854.12

**4658. Gravitational equilibrium of interstellar hydrogen.** G. A. GURZADIAN. *Astr. J., USSR*, **26** (*No.* 2) 94 (1949) *In Russian.* English Abstr. in *Astr. News Lett.* [*Harvard*] (*No.* 46).

Equilibrium is established when radiation pressure equals gravitational acceleration. The former is $F(r) = [kn_1H\alpha(r)]/c$; the latter, $G(r) = mg\,(n_1 + n^+)(R/r)^2$. For sufficiently small distances $F(r)/G(r) < 1$.

523.854.12

**4659. The space-reddening in the Milky Way according to photo-electric and visual-colorometric measurements.** K. GRAFF. *S.B. Öst. Akad. Wiss., Abt. IIa*, **157** (*No.* 1–5) 1–13 (1949) *In German.*

From 1930–47 the author employed his visual colorimeter for the study of colour excesses in extended Milky Way areas, comprising Sagittarius, Scutum, Cygnus, Cassiopeia, Camelopardalis and Perseus. He also determined the quantities colour minus spectrum, using a wedge-photometer. For 97 stars Graff now compares his results with those obtained by Stebbins, Huffer and Whitford in Madison, Wis., comprising stars brighter than 5 mag. and also a number of fainter ones, and gives a revised catalogue of their colour excesses, reduced to the Vienna colour system. The differences Madison minus Vienna are shown to be very small (particularly for the red stars), in spite of the fundamentally different observational methods. A. BEER

523.854.12

**4660. Ratio of total to selective absorption.** E. M. LINDSAY. Letter in *Nature, Lond.*, **165**, 363–4 (*March* 4, 1950).

A value for the ratio in the galaxy, $A/E = 6$, has been derived by comparing photoelectric colour excesses of Stebbins, Huffer and Whitford [Abstr. 375 (1940)] with an analysis of star counts down to photographic magnitude 13·0 within galactic longitudes 290°–360° and latitudes ± 30°. Values of $A$ were derived on the assumption that for certain of the brightest Milky Way regions obscuring clouds were absent, and that general absorption was also negligible; a systematic dependence of $A/E$ on $A$, attributed to these assumptions, is removed by assuming an absorption coefficient of 0·7 mag./kpc.

M. W. OVENDEN

523.855

**4661. The absolute brightness of the extra-galactic nebulae.** T. WIDORN. *S.B. Öst. Akad. Wiss., Abt. IIa*, **157** (*No.* 6–10) 321–30 (1949) *In German.*

523.855

**4662. Distribution of extragalactic nebulae in three selected areas.** C. D. SHANE AND C. A. WIRTANEN. *Proc. Amer. Phil. Soc.*, **94** (*No.* 1) 13–17 (1950).

523.87

**4663. Line intensities in spectra of advanced type.** A. PANNEKOEK. *Publ. Dom. Astrophys. Obs. Victoria, B.C.*, **8** (*No.* 5) 141–223 (1950).

Presents the results of a spectro-photometric study of III-prism spectrograms of 7 stars and the sky in the region 4 000 Å to 5 000 Å. The spectral range is from *F*3 to *G*6 and both giant and dwarf stars are included. Photometric problems connected with the reduction of the microphotometer records are investigated and discussed. The observed line profiles are analysed by a method which yields the intensities of the component lines making up the blend. The equivalent widths of the spectral lines in the above wavelengths range are given in a catalogue. A.

523.873

**4664. Spectra of variable stars in the Orion nebula.** G. H. HERBIG. *Astrophys. J.*, **111**, 15–19 (*Jan.*, 1950).

523.874

**4665. On the early appearance of atmospheric lines in the ultra-violet spectrum of ζ Aurigae.** M. G. FRACASTORO. *Mon. Not. Roy. Astr. Soc.*, **109** (*No.* 5) 586–93 (1949).

523.877

**4666. On the choice of numerical integration formulae in the solution of the integro-differential equations of transfer (radiation, neutrons) by the "method of discrete ordinates."** V. KOURGANOFF AND C. PECKER. *Ann. Astrophys.*, **12**, 247–63 (*Oct.–Dec.*, 1949) *In French.*

The method of Gaussian subdivisions and characteristic roots used by Chandrasekhar in his treatment of radiative equilibrium is not necessarily the most

effective one. Calculations of the 1st to the 4th approximations in the "standard problem" of isotropic diffusion in a plane parallel atmosphere are made using the Newton-Cotes and Tchebycheff formulae, and the former is found to give more accurate results in the 2nd and 4th approximations than are obtained by Chandrasekhar. This result is explained by discussing the distribution of the Gaussian subdivisions. R. A. NEWING

523.877

**4667. On the use of mean absorption coefficients in the construction of model stellar atmospheres.** R. MICHARD. *Ann. Astrophys.*, **12**, 291–304 (*Oct.–Dec.*, 1949) *In French.*

Approximations involved in the use of mean coefficients are discussed in detail and distinguished from those arising from the adoption of a grey model. Simple approximations lead to the Rosseland mean, if the effective temperature is prescribed, and otherwise to the "Planck mean" $\int \kappa_\nu(B_\nu/B)d\nu$. Model atmospheres constructed for different means are compared [see Abstr. 1437 (1950)], and it is concluded that errors arise chiefly from the use of absorption coefficients independent of frequency. R. A. NEWING

533.877

**4668. Neutral oxygen in stellar atmospheres.** P. C. KEENAN AND J. A. HYNEK. *Astrophys. J.*, **111**, 1–10 (*Jan.*, 1950).

523.877

**4669. On the integral equation governing the distribution of the true and the apparent rotational velocities of stars.** S. CHANDRASEKHAR AND G. MÜNCH. *Astrophys. J.*, **111**, 142–56 (*Jan.*, 1950).

523.877

**4670. Exact curves of growth for the formation of absorption lines according to the Milne–Eddington model. II. Center of the disk.** M. H. WRUBEL. *Astrophys. J.*, **111**, 157–64 (*Jan.*, 1950).

523.877

**4671. On the thermal conductivity in dense stars.** L. MESTEL. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 2) 331–8 (1950).

523.877 : 539.172.13

**4672. Proton-proton reactions in red dwarf stars.** L. H. ALLER. *Astrophys. J.*, **111**, 173–8 (*Jan.*, 1950).

The relative roles of the C cycle and of *p-p* reactions in red dwarf stars such as Krueger 60*A* and $\sigma^2$ Eridani *C* are studied with the aid of models calculated by Schwarzschild and Keller, in which the heavy stuff is taken as the Russell mixture and as O, respectively. The proportions of C-plus-N are taken as 0·08 and 0·15 for the *RM* and *O* models, respectively. The lifetime of the C cycle is $10^6$ yr for $\rho = 80$ gm/cm³, $T = 20\,000\,000$°K, and H content $X = 0{\cdot}35$. The adopted value of the Fermi constant is $1{\cdot}13 \times 10^{-4}$ sec$^{-1}$. The problem is to find a pair of $X$ (H content) and $Y$ (He content) values that satisfy the mass-luminosity relation for the model and for which observed and calculated energy output are equal. For the Russell mixture, two solutions are possible. In one, 60–70% of the energy comes from the C cycle, and the balance is supplied by the *p-p* reaction. In the second solution all the energy is contributed by the *p-p* reaction. For Krueger 60*A*, $X = 0{\cdot}11$, $Y = 0{\cdot}64$, $T_c = 15\,400\,000$°K, with 60% of the energy supplied by the C cycle; or, alternatively, $X = 0{\cdot}34$, $Y = 0{\cdot}64$, and $T_c = 10\,700\,000$°K, with *p-p* reactions delivering all of the energy. Stellar models in which the heavy material is all O are always too bright. No emphasis can be placed on the actual $X$ and $Y$ values, since the opacity law assumed for the sun cannot apply in red dwarfs, nor are the models valid when energy generation occurs outside the convective core. If further work shows that the composition approaches that of the O model, it may be necessary to assume a structure consisting of two zones of different molecular weight.

525.3

**4673. Motion of the earth about its centre of gravity.** K. A. POPOV. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 755–8 (1949) *In Russian.*

525.33

**4674. Two simple lecture experiments to demonstrate the earth's rotation.** H. BUCKA. *Z. Physik*, **126** (*No.* 1–2) 98–103 (1949) *In German.*

Experiments by Hagen (1911 and 1920) used a torsion device to measure angular velocities caused by changing (by a factor of 7) the moment of inertia of a system of 2 heavy carriages, each of 87 kg, which moved from each end of a 8·5 m long arm towards its centre; in 1·5 minutes a deflection of 0·4° became observable. Bucka's new device is a refinement using together with a special torsion balance only a simple 1·5 m rod which tilts from the horizontal into the vertical position, whereby the moment of inertia changes by the factor $10^4$, and gives rise to a $10^3$ times greater relative angular velocity than in Hagen's case. Two different kinds of experiments are worked out which make the earth's rotation clearly visible within a few seconds to a lecture audience (10° deflection in 2 sec), and this with an accuracy of about ± 20% and ± 5%, respectively. A. BEER

# PHYSICS 53

53.01

**4675. Quantal aspects of scientific information.** D. M. MACKAY. *Phil. Mag.*, **41**, 289–311 (*March*, 1950).

53.05

**4676. Morphological research.** F. ZWICKY. *Helv. Phys. Acta*, **23** (*No.* 1–2) 223–38 (1950) *In German.*

The object of morphological analysis and construction is defined as "totality-research," i.e. as dealing with the totality of the solutions of given problems. Even if not all of these solutions can be investigated or utilized constructively, morphological research should provide our knowledge of their existence. Detailed treatments are given of the morphology of the telescopes and of that of the flight. For the former, 5 general parameters are

troduced into the author's morphological matrix: , nature of the aperture; *B*, transformations of the ght rays; *C*, nature of the recording instrument; , relative movement of telescope and object; , position of the telescope. The implications of *D* the general possibilities in meteoric research, intillation, etc., are discussed as examples of pplications. A. BEER

53.081

**577. "Natural units" and electrodynamics.** M. LLE. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 3–5) 208–12 949) *In German.*

A discussion of several systems of units suitable for omic physics. A system which is based on 3 echanical, 1 thermal, 1 electrical and 1 magnetic it is treated in some detail. P. T. LANDSBERG

## FUNDAMENTALS 530.1

530.1 : 538.11

**578. A 4-dimensional generalization of Wilson's pothesis.** A. PAPAPETROU. *Phil. Mag.*, **41**, 399–404 pril, 1950).

Wilson's hypothesis of electric currents accompanying the rotation of electrically neutral matter (in der to explain the origin of the geomagnetic field) generalized in a 4-dimensional language. The main nsequences of the generalized formulation are scussed. A.

530.12

**579. The relation between the four- and five-mensional metric.** P. JORDAN. *Ann. Phys., Lpz.* olge 6) **3**, 153–5 (1948) *In German.*

A simple notation of covariant and contravariant dices is developed to deal with formulae relating to 5-dimensional metrics of relativity theory eated in previous papers [W. Pauli, *Ann. Phys., Lpz.*, , 305, 307 (1933) and Jordan, Abstr. 1422 (1948)]. W. J. SWIATECKI

530.12

**580. Unified field-theory in four dimensions.** ungar. *Acta Phys.*, **1** (*No.* 5) 1–6 (1949) *In German.*

530.12 : 523.112

**581. Two remarks on the cosmological problem.** . HÖNL. *Ann. Phys., Lpz.* (*Folge* 6) **6**, 169–76 (1949) *German.*

The momentum of a free particle in expanding herical space is shown to be $\propto$ world curvature; e application of this result to photons, cosmic rays d to the motion of extra-galactic nebulae is dissed. The expansion law for zero cosmological nstant is discussed, and it is concluded that (Hubble nstant)$^{-1} \sim 1{\cdot}7 \times 10^9$ yr provides an upper limit the age of the universe. R. A. NEWING

530.12

**582. Is it possible to measure the velocity of light a one-way basis?** M. GALLI. *Atti Accad. Naz. ncei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **6**, 620–6 (*May*, 49) *In Italian.*

A discussion of the ways in which is manifested in actice the impossibility of detecting, in an absolute theory, the effect of the motion of the earth on the velocity of light by means of first-order effects. L. PINCHERLE

530.12

**4683. Elements of kinematical relativity.** M. CAUSSE. *Ann. Phys., Paris*, **4**, 760–805 (*Nov.–Dec.*, 1949) *In French.*

The author begins with an account of the theory of two and of three fundamental observers and then passes on to the detailed consideration of accelerated particles. The dynamics of two particles is worked out in great detail both for gravitational and for electromagnetic interactions between them. The gravitational theory is equivalent to the Newtonian as far as observable effects are concerned. The author claims that he can obtain the Blackett formula for the magnetic field of a neutral rotating body. [His use of the terms "body" ("corps") and "particle" ("particule") appears to be ambiguous.] G. C. McVITTIE

530.12

**4684. The meaning of relativity.** A. EINSTEIN. *London, Methuen & Co. Ltd.* (1950) 145 *pp.*

The first 126 pages of this book reproduce the text of the 1945 edition issued by the Princeton University Press. It is regrettable that the opportunity was not taken to correct the misprints found in the earlier edition, though some have been removed. The remainder of the book is devoted to the Unified Field Theory announced in the press at Christmas 1949. The essence of this theory consists in the use of a non-Riemannian geometry based on a fundamental tensor $g_{ik}$ which is the sum of a symmetrical and an asymmetrical part. Geometrically this tensor is the analogue of the metrical tensor of Riemannian geometry but no physical meaning appears to be attached to it. A contracted curvature tensor can be constructed from $g_{ik}$ and Hamiltonian differentiation of an associated invariant produces field-equations in the usual way. Ten lines at the end of the book are devoted to the physical interpretation of this formalism but no attempt is made to show whether, and in what way, the electromagnetic equations obtained by the theory differ from Maxwell's equations. G. C. McVITTIE

530.12

**4685. On the place of experience in the construction of physical space by a solitary observer.** F. AESCHLIMANN. *C.R. Acad. Sci., Paris*, **230**, 519–21 (*Feb.* 6, 1950) *In French.*

Distances and epochs are defined as functions $f_R$ and $f_T$ of the times of emission and reception of light signals; restrictions on the functional forms $f_R$ and $f_T$ are discussed. R. A. NEWING

530.12

**4686. A remark on the coupling of gravitation and electron.** H. WEYL. *Phys. Rev.*, **77**, 699–701 (*March* 1, 1950).

In Einstein's theory of gravitation one may consider either the metric potentials $g_{ik}$, or both the metric potentials and the components of the affine connection, as independent quantities (metric *v.* mixed theory) in the coupling of gravitational and electronic fields. This makes a difference for the ensuing

equations, but one that can be easily rectified by a slight change of the Lagrangian. A.

530.12

**4687. World-structure and non-Euclidean honeycombs.** H. S. M. COXETER AND G. J. WHITROW. *Proc. Roy. Soc. A*, **201**, 417–37 (*April* 26, 1950).

Milne [*Quart. J. Math.*, **5**, 30 (1934)] described a one-dimensional system of discrete particles in uniform relative motion such that the aspect of the whole system is the same from each particle. The purpose of the present paper is to construct analogous systems in 2 and 3 dimensions. If the uniformly moving observers regraduate their clocks so as to describe each other as relatively stationary, the private Euclidean spaces of the special theory of relativity become public hyperbolic space. This point of view leads to a discussion of uniform honeycombs in hyperbolic space, 4 of which were discovered by Schlegel. One of the new honeycombs, called {4, 4, 3}, has for its vertices the points whose 4 co-ordinates are $\propto$ the integral solutions of the Diophantine equation $t^2 - x^2 - y^2 - z^2 = 1$. As a by-product, a simple set of generators and generating relations are obtained for the group of all integral Lorentz transformations. Another by-product is the enumeration of those groups generated by reflections in hyperbolic space whose fundamental regions are tetrahedra of finite volume. The work culminates in the discovery of a point-distribution whose mesh is 7 times as close as that of {4, 4, 3}, though apparently still far too coarse to be of direct cosmological significance. It follows that some irregularity in the distribution of the extragalactic nebulae is almost certainly geometrically inevitable. A.

530.12

**4688. On Tolman's equation describing the thermal equilibrium in a gravitating sphere of fluid.** H. A. BUCHDAHL. *Phil. Mag.*, **41**, 362–3 (*April*, 1950).

It is shown that by adopting a form of the line element slightly different from that chosen by Tolman a first-order equation for the dependence of proper temperature on gravitational potential in a gravitating fluid sphere appears in place of Tolman's second-order equation. The problem suggested by him concerning the meaning of a certain constant of integration therefore does not arise. A.

530.12 : 531.51 : 523.1

**4689. On projective relativity theory with variable gravitation invariants. II. Variation principles and field equations for gravitation and matter.** G. LUDWIG. *Z. Phys.*, **125** (*No.* 7–10) 545–62 (1949) *In German.*

The fundamental field equations for the gravitation-electromagnetic and $\kappa$-field ($\kappa$ = gravitation invariant, are formulated. The formal expression for the energy tensor and the phantom current [Vieverstrom] of matter are derived and the related conservation theorems investigated. A useful expression for a cosmological model is discussed. [See Abstr. 3739 (1950)]. H. G. SOLOMON

530.145

**4690. On the relativistic invariance of the interaction operator of two particles.** S. SLANSKY. *C.R. Acad. Sci., Paris*, **224**, 631–3 (*March* 3, 1947) *In French.*

Using the fact that the operator is invariant under Lorentz transformations, an explicit formula for th operator is found. This formula is simplified an some remarks are made about its use and inte pretation. L. S. GODDAR

530.14

**4691. Lagrange function of some elementary pa ticles.** L. A. RADICATI. *Atti Accad. Naz. Lincei* (*R. Cl. Sci. Fis. Mat. Nat.*) **3**, 351–6 (*Nov.–Dec.*, 1947) *Italian.*

Particles of arbitrary spin, neutral or with zero re mass, are represented by a single Lagrange functio as are particles of spin one. G. RIGHI

530.14

**4692. Tables useful for construction of irreducib representation matrices of symmetric group.** YAMANOUCHI. *J. Phys. Soc. Japan*, **3**, 245–53 (*July Aug.*, 1948).

530.14

**4693. Electron theoretical investigation of the mas spectrum of elementary particles.** F. BOPP. *Z. Phys.* **125** (*No.* 7–10) 615–28 (1949) *In German.*

Based on the Mie–Born theory of the electron i linear form the connection between the structure o the elementary particles and the observed mas spectrum is investigated. The wave equation of th fields is derived and discussed. Emission-reabsorptio processes are taken into account. Radiation effect are not considered. The investigation continue previous work on the quantum theory of field [Abstr. 1127 (1947)]. H. G. SOLOMO

530.14

**4694. An improvement on the integrations appearin in perturbation theory.** H. UMEZAWA AND R. KAWABE *Progr. Theor. Phys.*, **4**, 420–2 (*Oct.–Dec.*, 1949).

It is stated that the customary perturbation metho tends to destroy the relativistic covariance of certai quantities. This is traced back to the integrals which occur in perturbation theory, and it is pointed ou (i) that a sphere as a boundary surface in the momen tum space of a particle is not a relativistically invarian domain, (ii) that momentum conservation amon particles is not relativistically invariant witho energy conservation. Both difficulties can aris when particles are considered which are in an inter mediate state. Improvements are suggested.

P. T. LANDSBERG

530.14

**4695. Interference phenomena for particles obeyin Bose or Fermi statistics.** M. MOSHINSKY. *Proc Amer. Phil. Soc.*, **94** (*No.* 1) 53–86 (1950).

The product of the radiation intensities at two different points, as averaged over the phases, is shown classically to be subject to a so-called second order interference effect. The quantum-mechanical calculation shows that a similar effect occurs for particles which are subject to Bose statistics, but does not occur if the Boltzmann statistics is used. Fermi-particles are shown to exhibit an interference effect which is rather different. [There are several misprints in the numbers referring to formulae.]

P. T. LANDSBERG

530.145

**4696. A note on the relativistic invariance of quantized field theories.** J. S. DE WET. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 2) 316–18 (1950).

530.145

**4697. Exchange forces.** D. L. FALKOFF. *Amer. J. Phys.*, **18**, 30–8 (*Jan.*, 1950).

Brief explanation and discussion for non-specialists. 5 refs.)

530.145

**4698. Regularization as a consequence of higher order equations.** W. THIRRING. Letter in *Phys. Rev.*, **77**, 570 (*Feb.* 15, 1950).

530.145

**4699. Minimum and maximum limits of photon-energy.** G. J. WHITROW. Letter in *Nature, Lond.*, **165**, 281 (*Feb.* 18, 1950).

Milne's suggestion that $h \propto t$ implies a natural energy-unit $h/t$. The photon energy $E = hc/\lambda$ has the minimum value $h/t$ when $\lambda \sim ct$, the present radius of the universe. If the fundamental unit of length $h/mc$ is introduced, $E_{max} \sim mc^2$, the inertial energy of a proton. R. A. NEWING

530.145

**4700. Relativistic motion in a magnetic field.** M. H. JOHNSON AND B. A. LIPPMANN. *Phys. Rev.*, **77**, 702–5 (*March* 1, 1950).

A simple integral of the relativistic equations of motion for a charge in a magnetic field is used to reduce the Dirac equations to two simultaneous first-order differential equations. Eigenstates of this integral are the basis for a treatment of degeneracy and, in the case of a homogeneous field, for the construction of energy eigenfunctions from non-relativistic solutions. For a free particle the same integral leads directly to the only possible energy states with exactly defined spin projections. A.

530.145

**4701. Do the equations of motion determine the quantum mechanical commutation relations?** E. P. WIGNER. *Phys. Rev.*, **77**, 711–12 (*March* 1, 1950).

The commutator of the Hamiltonian with the operator corresponding to any physical quantity gives the operator which corresponds to the time derivative of that quantity. One can ask, hence, whether the postulate, that the quantum mechanical operators obey the classical equations of motion, uniquely determines the commutation relations. The answer is found to depend on the form of the Hamiltonian and is in the negative for a free particle and for the harmonic oscillator. A.

530.145

**4702. Multiple meson processes and nucleon recoil.** H. E. S. GREEN. Letter in *Phys. Rev.*, **77**, 719–20 (*March* 1, 1950).

530.145

**4703. Relativistic interactions between two nucleons.** C. MARTY. Letter in *Nature, Lond.*, **165**, 361–2 (*March* 4, 1950).

530.145

**4704. Interaction between elementary particles. II.** A. LANDÉ. *Phys. Rev.*, **77**, 814–16 (*March* 15, 1950).

See Abstr. 1513 (1950). A particle described by an exact $\delta$-function with shift of origin, rather than by a structural smoothed-out $\delta$-function, has equations of motion derivable from Fokker's least action principle, in analogy to Feynman's work. The two objections of arbitrariness of the structure function, and of violation of the linear field equations within the particle radius, are thereby avoided. The relation to Born's new theory of elementary particles is discussed. A.

530.145

**4705. On two-component wave equations.** F. GÜRSEY. Letter in *Phys. Rev.*, **77**, 844–5 (*March* 15, 1950).

530.145

**4706. The fields created by the proton and by the neutron.** L. DE BROGLIE. *C.R. Acad. Sci., Paris*, **229**, 640–3 (*Oct.* 3, 1949) *In French.*

The author suggests, tentatively, how the new conception, put forward in 3 recent notes [*C.R. Acad. Sci., Paris*, **229**, 157, 269, 401 (1949)] concerning the interaction between the elementary particles and the photon and meson fields, may be employed to advance the theory of nuclear fields. P. M. DAVIDSON

530.145 : 537.122

**4707. On elementary point-charges. A contribution to classical electron theory.** E. KRETSCHMANN. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 6) 331–4 (1949) *In German.*

It is shown classically that the assumption of elementary point charges is compatible with the conservation laws of energy, momentum and angular momentum. The main consequences of the equations are (i) that the energy density of an electro-magnetic field can be negative, (ii) that for the radiation of energy the presence of at least two accelerated elementary point charges is required. P. T. LANDSBERG

530.145 : 539.152.1

**4708. On a new theory of nuclear forces.** H. J. BHABHA. *Phys. Rev.*, **77**, 665–8 (*March* 1, 1950).

A new theory of nuclear forces is based on the result established in an earlier paper that if the matrix $\alpha^0$ in the field equations $(\alpha^k p_k + \chi)\psi = 0$ satisfies the minimal equation $\{(\alpha^0)^2 - 1\}^2(\alpha^0)^s = 0$ ($s$ = any integer), then every component of the field $\psi$ satisfies the iterated generalized wave equation $(\Box + \chi^2)^2\psi = 0$ of the fourth order. The static potential between two nucleons is then a sum of the interaction between two point charges and the dipole-dipole interaction multiplied by numerical coefficients and isotopic spin factors. This interaction, unlike the usual one based on the Yukawa theory, allows an exact solution of the deuteron problem. The potentials based on more complicated fields satisfying the $n$ times iterated generalized wave equation are also given. A.

530.145 : 539.18

**4709. On the reflection of particles of spin $h/2\pi$.** G. PETIAU. *C.R. Acad. Sci., Paris*, **224**, 187–9 (*Jan.* 20, 1947) *In French.*

A pencil of particles is considered. The trajectories are parallel and the potential distribution is: $x < 0$, $V = 0$; $x > 0$, $V =$ const. Wave-functions describing the motion in each space are written down, and an examination of the boundary conditions leads to explicit formulae for the amplitudes of the reflected and transmitted waves. L. S. GODDARD

530.145 : 539.18

**4710. Applicability of Pauli's regulator to the γ-decay of neutrettos.** H. FUKUDA, Y. MIYAMOTO, T. MIYAZIMA, S. TOMONAGA, S. ÔNEDA, S. OZAKI AND S. SASAKI. *Progr. Theor. Phys.*, **4**, 477–84 (*Oct.–Dec.*, 1949).

The conditions to be imposed in pseudoscalar theory [Abstr. 1497 (1950)] are obtained in detail, and the scalar and vector theories are examined.

G. J. KYNCH

530.145 : 539.18

**4711. On the production of π-mesons in nucleon-nucleon collisions.** S. TAKAGI. *Progr. Theor. Phys.*, **4**, 557–64 (*Oct.–Dec.*, 1949).

The production of pseudoscalar mesons is calculated using Schwinger theory. For low energy protons the product is mainly by the Bremsstrahlung process involving the nuclear forces operator. For high-energy protons the main production of low-energy mesons is similar and also has spherical symmetry. For high-energy mesons the main production comes from the pseudovector coupling terms involving meson currents, the mesons being emitted in the direction of the incident proton. G. J. KYNCH

530.145.6

**4712. On the modification of the Hamiltonian of a nuclear particle due to its virtual dissociation.** G. ARAKI. Letter in *Progr. Theor. Phys.*, **2**, 89–90 (*March–June*, 1947).

530.145.6

**4713. A new wave-mechanical perturbation theory.** H. KALLMANN AND M. PÄSLER. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 305–16 (1948) *In German.*

The method of solving the wave equation by the Laplace transformation previously developed by the authors [Abstr. 54–55 (1949)] is extended, and can be used if the transform of the unperturbed differential equation is a differential equation of the first order. The general method is outlined for a certain form of the perturbing function. Two-thirds of the paper deals with an application to the equation

$$xy'' + ay' + (b + cx + dx^2)y = 0$$

(Stark effect). The usual results are obtained.

P. T. LANDSBERG

530.145.6

**4714. On the eigenvalue problem of hydrogen.** G. ARAKI. Letter in *Progr. Theor. Phys.*, **4**, 366–7 (*July–Sept.*, 1949). See Abstr. 4715 (1950).

530.145.6

**4715. Domain of kinetic energy and perturbation theory.** G. ARAKI. Letter in *Progr. Theor. Phys.*, **4**, 379–80 (*July–Sept.*, 1949).

530.145.6

**4716. The second approximation of the asymptotic phase for the Yukawa potential, treated with Laplace-transformations.** G. KÄLLÉN. *Ark. Fys.*, **2**, *Paper* 6, 33–46 (1950).

The Schrödinger equation is here solved with the aid of an expansion in the coupling-constant. Every term in the series is written as a Laplace-integral, and from this the asymptotical behaviour of the solution is easily obtained. The asymptotic phase will then also be expressed as a power series in the coupling-constant. The first term corresponds to the usual Born's approximation, the higher terms can be considered as corrections for this formula. In this paper the explicit calculations are carried out only to the second approximation and for small angular momenta (*S*- *P*- and *D*-states). The numerical results are compared with earlier approximate formulae of Pais and Ramsey and with the more accurate calculations made by the variational method of Hulthén.

A

530.145.6

**4717. The mass defect as a consequence of the relativistic field equation for the two-body problem.** W. THIRRING. *Z. Naturforsch.*, **5a**, 85–8 (*Feb.*, 1950). *In German.*

Establishes the relativistic wave equation for two particles of spin ½. Using scalar coupling, it is shown that the system behaves like a single particle whose mass is the sum of the individual particle masses minus the binding energy. This result is, however, very sensitive to the assumed type of coupling. The work is a development of a paper by Bagge [Abstr. 750 (1947)]. P. T. LANDSBERG

530.145.6

**4718. On wave equation vector-matrices and their spurs.** R. J. DUFFIN. *Phys. Rev.*, **77**, 683–5 (*March* 1, 1950).

If a system of tensor (or spinor) equations may also be written in the matrix form $P\psi = \psi'$ where the column matrices $\psi$ and $\psi'$ undergo the same transformation under a change of co-ordinates, then the square matrix $P$ is termed a *vectrix*. General considerations indicate that $P$ should obey invariant matrix identities. Of course, the matrix $P$ merely images an operation implicitly defined in the original system of equations in terms of a set of tensor parameters $p$. A natural method to seek identities is to iterate this operation in the original system with different values ascribed to the parameters. Of especial interest are the vectrices defined by wave equation systems such as those of Dirac and Proca. Here $p$ is to be interpreted as the 4-vector of momentum and energy. By carrying out the iteration process, various identities are found. In particular, formulae are obtained for the spur of the product of an arbitrary number of Proca vectrices. A.

530.145.6 : 531.31

**4719. Kinematic properties of a rigid body in wave mechanics.** A. GOUDOT. *C.R. Acad. Sci., Paris*, **230**, 1140–2 (*March* 20, 1950) *In French.*

530.145.6 : 536.75

**4720. Quantum mechanics and the second law of thermodynamics.** M. BORN. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 107–14 (1948) *In German.*

A brief account of the position of entropy in classical and quantum mechanics according to the work of Born and Green. It is shown how the equation $\partial f/\partial t - [H, f] = 0$ ($f$ = distribution function in phase space, $H$ = Hamiltonian, $[A, B]$ = Poisson Bracket) can be made the basis not only of Gibbs' statistical mechanics, but also of a kinetic theory of gaseous and condensed matter [Abstr. 771 (1947)]. The principle of increasing entropy in classical mechanics is obtained if certain parameters,

which can be known in principle, are, in fact, unknown Abstr. 1147 (1947)]. The above equation, now with $[A, B] = i(AB - BA)$, is retained in quantum mechanics and determines the density matrix $f$ in Abstr. 3435 (1947), 957 (1948). From a suitable definition of the entropy its usual properties can be derived. Hence irreversibility is shown to have its source in the quantum mechanics itself, whereas it is due to limited information in classical mechanics.

P. T. LANDSBERG

530.145.6 : 537.533.74

**4721. On numerical computation of Coulomb wave functions.** C.-E. FRÖBERG. *Ark. Fys.*, **2**, *Paper* 5, 27–32 (1950).

Representations of Coulomb wave-functions are given in terms of real integrals, some new and some old, that can be used for numerical work, especially when one or a few values of the function are needed.

G. J. KYNCH

530.145.6 : 539.132

**On the quantum mechanics of regular structures of finite extent.** *See Abstr.* 5183

530.162

**4722. Statistics of condensed systems.** B. T. GEĬLIKMAN. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 65–8 (1950) *In Russian.*

530.162

**4723. On the theory of grand partition functions.** A. MÜNSTER. *Proc. Camb. Phil. Soc.*, **46** (*Pt* 2) 219–30 (1950).

The grand partition function is derived by averaging over all partitions and numbers of molecules of a grand ensemble. The statistical parameters that arise are interpreted thermodynamically. A formula for the mean fluctuation of the numbers of molecules is deduced, and it is shown that the latter can become very great for singularities of the partial potentials. In that case, the system becomes statistically indeterminate, and separates out into several phases. Conversely, in the statistics of actual systems, the search for singularities, at which the partial potentials become independent of the composition, leads to the conditions under which a phase-change takes place. It is shown that, on certain hypotheses, the grand partition function is the generating function of the ordinary partition function, and that the latter can always be represented in product-form. The generating function of a factor in this product-form is called a reduced grand partition function. The significance of its parameters is discussed, and their use in the statistical thermodynamics of liquid mixtures is reviewed. A.

530.162

**4724. On the configuration integral for one dimensional system of particles.** L. VAN HOVE. *Physica*, **16**, 137–43 (*Feb.*, 1950) *In French.*

The free energy of a one-dimensional system of particles is calculated for the case of non-vanishing incompressibility radius of the particles and a finite range of the forces. It is shown quite generally that no phase transition phenomena can occur under these circumstances. The method used is the reduction of the problem to an eigenvalue problem. A.

## GENERAL MECHANICS MECHANICS OF SOLIDS 531

531.24 : 523.842

**4725. On the motion of the centre of gravity of a system of two radiating bodies.** W. OPALSKI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **1**, 840–6 (*July–Aug.*, 1946) *In French.*

Because of loss of mass through radiation of energy the motion of the centre of gravity of a system of double stars is, in general, non-uniform. From the conditions required for the motion of the centre of gravity to be uniform, the author concludes that the only case when this is possible, without violating Eddington's mass-luminosity law, is when the components of the system are of equal masses. The author concludes, however, that, in general, the acceleration of the centre of gravity is negligible compared with the Newtonian acceleration of the component stars.

V. C. A. FERRARO

531.266

**4726. Potential of masses of zero algebraic sum.** O. FROSTMAN. *K. Fysiogr. Sällsk. Lund Förh.*, **20** (*No.* 1) 1–21 (1950) *In French.*

An abstract mathematical paper in which potential is defined for $m$-dimensional space. Existence theorems and problems of convergence are discussed, and various properties of integrals involving potential are established for $m = 3$. R. A. NEWING

531.35

**4727. The trajectory of a powered rocket in space.** G. F. FORBES. *J. Brit. Interplan. Soc.*, **9**, 75–9 (*March*, 1950).

Presents a mathematical analysis applicable to a rocket in a central force space under the general condition of thrust tangent to the rocket path. The general non-linear second-order differential equation is set up for the relations between the forces. The energy equation is developed and shown to be equivalent to the force equation. The equations are studied and various expressions are developed. The time integral is set up and minimized for the real and for the imaginary part of the original (complex) vector equation. These minimal differential equations are combined with the given equations to determine the necessary conditions for a minimal curve. Special cases are chosen for which the equations of motion are easily integrated. One of these cases is developed in some detail and a specific example worked out. It is shown that this special case (the logarithmic spiral) simplifies the mathematics of navigation. It is also shown that considerable saving of high thrust (low efficiency) motive power is possible when it can be replaced by continuous low thrust (high efficiency) power. A.

531.383

**4728. Making visible the impulse axis of rotation of the force-free top.** R. HAGEDORN. *Z. Phys.*, **125** (*No.* 7–10) 542–4 (1949) *In German.*

The process described resembles the method for the direct observation of the instantaneous axis of rotation. Instead of the usual embossed or printed paper disc, one with a system of concentric circles is used. H. G. SOLOMON

## MECHANICAL MEASUREMENTS 531.7

531.71 : 621.317.39 : 621.383

**4729. A method for the summation of irregular linear movements.** P. W. ROBERTS. *J. Sci. Instrum.*, **27**, 105–6 (*April*, 1950).

A photoelectric method is described. The principle is to divide any displacement into increments of known length, small compared with the average movement, and count these automatically by a scaling unit commonly employed in G.M. counting. The accuracy of the method is discussed and improvements are suggested. A.

531.715.1 : 535.417

**4730. Measuring a large displacement by interferometry.** H. BARRELL AND M. J. PUTTOCK. *Brit. J. Appl. Phys.*, **1**, 87–91 (*April*, 1950).

A modified form of Michelson interferometer is used to calibrate the mechanical displacement system of an adjustable cavity resonator used to measure the velocity of propagation of electromagnetic waves. For the calibration a linear displacement of 12·7 cm was determined in standard Kr wavelengths to an accuracy of one part in a million, utilizing techniques of fringe observation and calculation which do not involve counting a progression of fringes. Displacements $\geqslant$ 30 cm can be similarly measured if suitable sources of monochromatic radiations are employed. A.

531.717.3 : 621.317.39

**4731. Measurement and amplification of minute displacements by frequency modulation.** P. A. BRICOUT AND M. BOISVERT. *Rev. Sci. Instrum.*, **21**, 98–9 (*Jan.*, 1950).

531.719.1

**4732. Determination of curvature by an osculometer.** H. L. CURTIS. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 131–4 (*Feb.*, 1950).

The experimental determination of the curvature at a point of a plotted curve can be made by means of an osculometer, which is a series of arcs of known curvature. One use of such information is in the computation of the acceleration of a body for which a displacement-time curve has been constructed. By this method the acceleration can be obtained with the same accuracy as by double differentiation without the necessity of plotting the velocity/time curve. A.

531.75 : 621.317.39

**4733. Electrical weighing.** H. I. ANDREWS. *Instn Elect. Engrs, Paper* 894 (1949) 12 *pp.*

While measurements of weight can usually be made with accuracy using conventional apparatus, difficulty is experienced on moving vehicles, in enclosed or remote positions, or where the object to be weighed forms part of a working system. For such circumstances an electrical weighing apparatus has been developed comprising one or more small elements, having negligible deflection under load, from which a small voltage can be obtained $\propto$ the weight supported, together with an electronic voltage indicator. Weighing elements giving outputs of 0·1–0·3 V are described, and their design limits and max. sensitivity are considered. The outputs of a number of such elements can be summed, any desired amount of the weight supported can be "counterbalanced out," and the effects of parasitic motion of a vehicle can be eliminated, by electrical means. The principle has also been applied to the measurement of pressure. The determination of the weight of unburnt fuel on the grate of a steam locomotive in service is described. A

531.758 : 533.1

**4734. The determination of gaseous densities.** B. LAMBERT AND C. S. G. PHILLIPS. *Philos. Trans. A* (*No.* 851) 415–38 (1950).

The microbalance technique for the determination of gaseous densities is examined and the requirements stated for its use as a method of high precision and reliability. A detailed description is given of the construction of a sensitive and stable quartz microbalance and of the precautions necessary to obtain reproducible gas-pressure measurements of high precision. The improved technique is used for the determination of the atomic weights of C and N by the comparison of the pressure ratios at "limiting density" of the pure gases $N_2$, $CH_4$ and $O_2$; the values obtained are: N, 14·0078 (±0·0003); C, 12·0112 (±0·0005). $N_2$ prepared by heating pure, dry sodium azide is shown to contain traces of H (either in the free state or combined with N as $NH_3$), and a new method is described of purifying nitrogen made by this method. A.

531.765 : 621.318.572

**4735. Electronic pulse counters. II. Chronometer using electronic counting.** A. PEUTEMAN. *Onde Elect.*, **29**, 330–5 (*Aug.–Sept.*, 1949) *In French.*

A simple electronic chronometer with $10^5$ c/s oscillator, electronic switch and scaler (hard-valve scale-of-64, thyratron scale-of-100 and mechanical counter). See Abstr. 6284 (1949) A. O. STANESBY (R).

## MECHANICS OF FLUIDS 532

532.13

**4736. Structure viscosity of high polymer solutions.** A. ISHIHARA. *J. Phys. Soc. Japan*, **3**, 291–4 (*Sept.–Dec.*, 1948).

532.133

**4737. Correlating viscosities.** D. F. OTHMER AND S. J. SILVIS. *Industr. Engng Chem.*, **42**, 527–8 (*March*, 1950).

Viscosities of solutions of solids in liquids or of mixtures of liquids have been correlated on a logarithmic plot against vapour pressures or viscosities of a reference substance at the same temperature. In the case of aqueous solutions of caustic soda, the plot of viscosity against the viscosity of water eliminates the break in the function otherwise experienced at 40°C. A nomograph is presented. A.

532.137

**4738. A simple method and an instrument for investigating the flow behaviour of highly viscous fluids.** H. WILLENBERG AND W. FRITZ. *Angew. Chem.*, 16 *pp.* (*May–June*, 1948) *In German.*

A capillary viscosimeter for viscosity measurements

nder varying shearing stresses within the viscosity ange of $10^1$ to $10^6$ poise is described. The substance be investigated is contained in two cylindrical hambers which are inter-connected by a capillary ube. The experimental sample is forced back and rward through the capillary by means of pistons tting in the cylinders. By this means a sample can e repeatedly stressed and measured; this is a ecessary feature for the investigation of substances ith structural viscosity. The instrument is suitable r use at temperatures from −80°C to well over -100°C. The range of measurement can be further tended to accommodate higher values ($10^4$ to $10^{10}$ oise) by changing the dimensions.

INDEX AERONAUTICUS

532.517

**4739. Use of an optical property of glycerine-water olutions to study viscous fluid-flow problems.** W. W. AGERTY. *J. Appl. Mech.*, **17**, 54–8 (*March*, 1950).

It is a property of certain concentrations of lycerine-water solutions, when in a state of steady ow, that the planes of equal shear in the liquid ecome visible in ordinary light, if viewed along a ath tangent to the shear plane. This phenomenon as been used successfully to study a fluid-flow roblem. A.

532.517.4

**4740. Correlation problems in a one-dimensional odel of turbulence. I–II.** J. M. BURGERS. *Proc. K. ed. Akad. Wet.*, **53** (*No.* 3) 247–60; (*No.* 4) 393–406 950).

532.517.4

**4741. On the laminar sub-layer in the turbulent oundary layer. I.** Y. SHIGEMITSU. *J. Phys. Soc. apan*, **4** (*No.* 2) 61–5 (*March–April*, 1949).

532.517.4

**4742. On the laminar sub-layer in the turbulent oundary layer. II. On an approximate solution for he flow along a flat plate.** Y. SHIGEMITSU. *J. Phys. oc. Japan*, **4** (*No.* 3) 123–8 (*March–April*, 1949).

532.517.4

**4743. On the laminar sub-layer in the turbulent oundary layer. III. On the laminar sub-layer for the ow with a pressure gradient.** Y. SHIGEMITSU. *J. Phys. oc. Japan*, **4** (*No.* 3) 129–36 (*March–April*, 1950).

532.517

**4744. Viscous flow transverse to a circular cylinder.** . N. DAVIES. *Proc. Phys. Soc., Lond. B*, **63**, 288–97 *April*, 1950).

532.517.3 : 536.75

**4745. The critical Reynolds number for flow in a ube, and the entropy principle.** W. MEISSNER AND . U. SCHUBERT. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 163–82 948) *In German.*

The pressure and temperature distributions in a uid flowing along a tube are different when the flow turbulent from when it is laminar. Since the ntropy of the fluid depends on its pressure and mperature, the entropy differs in the two cases. he entropy in laminar flow of a perfect gas in a very ightly convergent tube is derived wholly theoretically om a series solution of the flow equations. No rmal solution is possible for turbulent flow, and in this case experimental observations on the pressure distribution, heat exchange and energy dissipation are combined to provide an estimate of the entropy of the gas stream. It is found that a critical Reynolds number exists, below which the entropy of laminar flow is greater, and above which smaller, than that of turbulent flow. This critical Reynolds number is identified with that for transition from laminar to turbulent flow. The estimated value lies within the range 1 600–1 900, some uncertainty being introduced by slight variations in the experimental data used.

A. SCHOFIELD

532.517.4 : 538.6

**4746. On the spontaneous magnetic field in a conducting liquid in turbulent motion.** G. K. BATCHELOR. *Proc. Roy. Soc. A*, **201**, 405–17 (*April* 26, 1950).

The fluid is assumed to be incompressible and in homogeneous turbulent motion, and externally imposed electric and magnetic fields are assumed to be absent. The equations governing the interaction of the electromagnetic field and the turbulent motion are set up with the same assumptions as are used to obtain the Maxwell and current flow equations for a metallic conductor. It is shown that the equation for the magnetic field is identical in form with that for the vorticity in a non-conducting fluid; immediate deductions are that lines of magnetic force move with the fluid when the conductivity is infinite, and that the small-scale components of the turbulence have the more powerful effect on the magnetic field. The first question considered is the stability of a purely hydrodynamical system to small disturbing magnetic fields, and it is shown that the magnetic energy of the disturbance will increase provided the conductivity is greater than a critical value determined by the viscosity of the fluid. The rate of growth of magnetic energy is approximately exponential, with a doubling time which can be simply related to the properties of the turbulence. General mechanical considerations suggest that a steady state is reached when the magnetic field has as much energy as is contained in the small-scale components of the turbulence. Estimates of this amount of energy and of the region of the spectrum in which it will lie are given in terms of observable properties of the turbulence. A.

532.52

**4747. Experimental data on the viscous force exerted by a flowing fluid on a dense swarm of particles.** H. VERSCHOOR. *Appl. Sci. Res.*, **A2** (*No.* 2) 155–61 (1950).

Experimental evidence is presented to support Brinkman's modification of Darcy's law for fluid flow through porous media [Abstr. 841 (1948)]. The results of the measurements performed are in close accordance with the prediction from theory. A.

532.58

**4748. A note on collapsing cylindrical shells.** T. E. STERNE. *J. Appl. Phys.*, **21**, 73–4 (*Feb.*, 1950).

Expressions are obtained for the instantaneous dependence of pressure upon radius within a collapsing cylindrical shell of incompressible liquid when subjected to (*a*) neither external nor internal pressure or to (*b*) an external pressure but no internal pressure.

Dynamical considerations suggest that very high pressures and radial velocities should be reached. A.

532.582.3

**4749. The forces on a submerged spheroid moving in a circular path.** T. H. HAVELOCK. *Proc. Roy. Soc. A.*, **201**, 297–305 (*April* 26, 1950).

532.582.7

**4750. Effects of particle shape on settling velocity at low Reynolds numbers.** J. S. MCNOWN AND J. MALAIKA. *Trans. Amer. Geophys. Un.*, **31**, 74–82 (*Feb.*, 1950).

532.595

**4751. The production of mechanical oscillations in a mercury capillary by a high frequency electrical impulse.** H. LAFONTE. *Ann. Phys., Lpc. Folge* 6 **4** (*No.* 1–2) 92–6 (1948) *In German.*

Mechanical oscillations of Hg in a capillary tube were produced by passing a high frequency current through the Hg for a very short time. The effect was photographed both by a high speed camera and by a rotating drum camera using the light from an intermittent spark. The mechanical oscillations started 0·005 sec after the commencement of the electrical impulse and continued after it had died away. The periodic time and maximum velocity of the mechanical oscillations were measured. It is shown that these oscillations were not due to the heating effect of the current. T. C. TOYE

## CAPILLARITY 532.6

532.61

**4752. Surface tension of molten zinc borates.** L. SHARTSIS AND R. CANGA. *An. Real Soc. Esp. Fis. y Quim.*, **45A**, 349–58 (*July–Aug.*, 1949) *In Spanish.*

The surface tension of melts in the system ZnO—$B_2O_3$, ranging from 0 to 79·5% of ZnO, were measured with a maximum-pull-on-cylinder method. In the two-liquid region which extends from approximately 0 to 53% of ZnO, the value of surface tension was that of $B_2O_3$ within the limits of experimental error. With percentages of ZnO beyond the two-liquid region the surface tension value increased rapidly with increasing content. Melts containing approximately 55 to 65% of ZnO showed maxima in the curves of surface tension *v.* temperature. Melts containing approximately 65 to 75% of ZnO had positive temperature coefficients of surface tension. The melt containing 79·5% of ZnO had a negative temperature coefficient of surface tension. The densities at room temperature were measured also. A.

532.61.08

**4753. Capillary phenomena with a horizontal suspended circular cylinder.** B. HARTMANN. *Ann. Phys., Lpc.* (*Folge* 6) **4** (*No.* 7) 359–70 (1949) *In German.*

In the stirrup method of measuring surface tension there is often an error of unknown magnitude due partly to the fact that the contact angle is not exactly zero. The author discusses the theoretical aspects of the errors involved by considering the shape of the liquid surface lifted up by a cylinder suspended in the surface. If an accuracy of 0·1% is sufficient and stirrup wire of 0·1 mm thickness is used the equation given by Lenard [*Ann. Phys.*, **74**, 381–404 (*Jan.* 1924)] is satisfactory. However, if greater accuracy is required then the formula developed in the present paper should be used. Examples are quoted showing the effect of the errors in the case of water at 20°C. A. [illegible]

532.6

**4754. Surface tension of regular solutions.** DEFAY AND I. PRIGOGINE. *Trans. Faraday Soc.*, [illegible] 199–204 (*March*, 1950).

532.65 : 538.

**4755. Interferometric studies on the surface tension depression in mercury and the accuracy of the mercury barometer.** E. T. LEVANTO. *Ann. Acad. Sci. Fennicae Ser. A1* (*No.* 8) 7–44 (1941) *In German.*

The radius of curvature of the meniscus is evaluated by measuring the Newton's rings formed between the meniscus and a flat, tube diameters being 15–25 mm. Success of the experiments depended upon the use of a vibration-free mounting which is described in detail. The dependence of meniscus height on tube diameter is examined. The technique is applied to the barometer and microseismic earth vibrations are found to lead to oscillations of the barometer level. The amplitude of oscillation is of the order of 0·005 mm Hg. The sensitivity of the Hg barometer is studied and it is shown that in general the barometer cannot respond to pressure differences of 0·0025 mm Hg. S. TOLANSKY

532.6

**4756. The stability of structures at a fluid interface.** D. J. CRISP. *Trans. Faraday Soc.*, **46**, 228–35 (*March* 1950).

An idealized array of parallel equidistant hairs, cylindrical in cross-section, can maintain a pressure difference across a liquid-vapour interface by virtue of the cylindrical bubbles formed when there is a finite angle of contact between the liquid and the surface of the hairs. A theoretical analysis of the forces operating upon such a system is given. A.

532.6[illegible]

**4757. The maximum life of bubbles in oil.** F. H. CONSTABLE AND S. REIZL. *Instumbl. Univ. Fac. Fis. Mec.*, **10**, 42–53 (*Jan.–Oct.*, 1945).

Experiments were carried out on the effect of bubble size on the rate of fall of oil foams in glass tubes. It is concluded that the maximum life of a single bubble is a linear function of diameter between 0·1 and 1·0 cm. for larger bubbles the maximum life falls again. In a foam, the smaller bubbles have the longest life. A. [illegible]

## MOLECULAR THEORY OF LIQUIDS 532.7

532.72

**4758. Solubility and rate of dissolution of oxygen in liquids.** T. AUDYKOWSKI. *Diss. E.T.H. Zurich*, 85 pp. (1944) *In German.*

The most important methods of determining the

lubility of oxygen in liquids are reviewed. The ethod of boiling out the dissolved oxygen is, in neral, not so accurate as Winkle's iodometric ration. It was confirmed that the Ostwald absorp- on coefficient depends chiefly on the surface tension the solvent. The slope of the surface-tension lubility curve depends on the polarity of the lvents. In the case of stirred homogeneous liquids e rate of dissolution depends on the solubility and scosity of the solvent. The variation of the rate of ssolution with speed of stirring was investigated r $H_2O$ and benzene. At small speeds (up to rotations per min.) the rate of dissolution is dependent of the rate of stirring, and is the same for the liquid at rest, but at greater speeds the rate dissolution is almost proportional to the speed. hen $H_2O$ was covered with a layer of paraffin oil e rate of dissolution was decreased, but not when e $H_2O$ was covered with benzene. In columns of $_2O$ at rest the absorption of $O_2$ proceeds largely by nvection, the amount taken up due to diffusion ing very small. A. J. MEE

532.72

759. **On the theory of extraction from falling roplets.** R. KRONIG AND J. C. BRINK. *Appl. Sci. es.*, **A2** (*No.* 2) 142–54 (1950).

The extraction of a substance, dissolved in droplets f a fluid, when these are falling (or rising) in another uid under the influence of gravity, is investigated. he circulation currents which are caused in the roplets by the viscous forces between the two fluids odify the rate of extraction as compared with the se of droplets at rest. Under certain simplifying ssumptions a differential equation governing the ombined action of convection and diffusion is erived. The rate of extraction follows from the olution of an eigenvalue problem. A.

532.72

760. **On a diffusion effect in flowing solutions and as-mixtures.** H. TOLLERT. *Naturwissenschaften*, **37** (*No.* 2) 41–2 (1950) *In German.*

A mixed solution of N/2 LiCl and N/2 HCl was orced by an excess pressure of 1·5 atmos. through a apillary tube 0·8 mm dia. and 70 cm long. It was ound that the conc. of LiCl was greater in the centre f the cross-section than near the walls. A similar ffect was noticed in convection currents in a soln. of KCl in $H_2O$ (300 g cm$^{-3}$): the conc. of KCl was higher y about 0·2% in the most rapidly-moving regions of he fluid, where the velocity was approx. 5 mm/s. he phenomenon is attributed to the fact that the pecific surface of a particle decreases as its radius ncreases, as a result of which larger particles make ess contribution to the viscosity than do similar maller particles. If both large and small particles re present in a stream of fluid, the larger particles ill therefore tend to accumulate where the rate of ow is greatest. A. SCHOFIELD

532.78 : 541.182.7

761. **X-ray diffraction by aqueous systems of riethanolamine laurate.** S. S. MARSDEN, JR. AND . W. MCBAIN. *Nature, Lond.*, **165**, 141–2 (*Jan.* 28, 950).

A review of recent publications on the X-ray iffraction patterns of the medium-concentration liquid-crystalline phase, the high-concentration liquid-crystalline phase, and the solid soap itself.

R. B. SHEPHERD

## MECHANICS OF GASES 533

533.12 : 531.758

**The determination of gaseous densities.** *See Abstr.* 4734

533.15

4762. **The effect of pressure on the thermal diffusion ratio.** H. G. DRICKAMER AND J. R. HOFTO. *J. Chem. Phys.*, **17**, 1165 (*Nov.*, 1949).

This was studied for mixtures of A and Ne in a two-bulb apparatus at low pressures (0·5 to 2 atmos.) and at temperatures well above the critical. No effect was found. R. H. DAVIES

533.15

4763. **Diffusion coefficients in multicomponent gas mixtures.** D. F. FAIRBANKS AND C. R. WILKE. *Industr. Engng Chem.*, **42**, 471–5 (*March*, 1950).

An experimental study has been made of the diffusion of vapours into multicomponent gases by vaporization of liquids in a long tube under conditions such that the theory of diffusion in the semi-infinite column is applicable. A.

533.15

4764. **Thermal diffusion of water-vapour.** R. H. DAVIES AND J. T. KENDALL. Letter in *Nature, Lond.*, **165**, 487 (*March* 25, 1950).

In a hot-wire (900°C) thermal diffusion column operating with water vapour at atmospheric pressure and a cold wall temperature a little above 100°C it has been found that the heavier molecules, containing $O^{18}$, concentrate at the *top* of the column. Thus the water molecule, under these conditions, is softer than the Maxwellian molecule and its force index is approximately calculated to be 4·9 from the measured column equilibrium separation factor.

W. H. DENTON

533.16

4765. **New measurements of the viscosity of water vapour.** H. ERYTHROPEL. *Brennstoff-Wärme-Kraft* [*BWK*] **1**, 215–18 (*Nov.*, 1949) *In German.*

Russian, American and German results are compared. The accuracy of all results, especially at high pressures and temperatures, is doubtful and further studies are required to obtain a sound basis for the calculation of flow and heat transfer problems.

COAL UTILISATION RESEARCH ASSOCIATION

533.5 : 531.788.7

4766. **The Pirani effect in a thermionic filament as a means of measuring low pressures.** L. SPIERS AND W. P. JOLLY. *Brit. J. Appl. Phys.*, **1**, 132–3 (*May*, 1950).

The Pirani cooling of a W thermionic filament has been investigated down to a pressure of the order of $10^{-6}$ mm Hg. The heating voltage applied to the filament to produce a given emission falls as the pressure is reduced and calibration curves of this voltage against log of pressure suggest that the effect could be used in a simple pressure gauge covering the

range $10^{-2}$ to $10^{-6}$ mm Hg and below. The filament works at such a low temperature that a sudden accidental inrush of air does not affect it, and the change in heater voltage is large enough (several V over whole range) to be measured by a robust pointer instrument. A.

533.59

**4767. Method of supplying low pressure gases on a vacuum system.** R. H. McFee. *Rev. Sci. Instrum.*, **21**, 100–1 (*Jan.*, 1950).

533.6.011

**4768. Flow of heated gases.** A. S. Thompson. *J. Appl. Mech.*, **17**, 91–8 (*March*, 1950).

A graphical design method has been developed, using the Reynolds analogy between heat transfer and friction, for one-dimensional flow in a passage of variable area, and with variable wall temperature. A.

533.6.011

**4769. The estimation of velocities and local Mach numbers in the flow of a compressible fluid through divergent nozzles, under adiabatic and isothermal conditions.** R. K. Tempest. *Phil. Mag.*, **41**, 382–92 (*April*, 1950).

533.6.011.5

**4770. Tables useful for the numerical calculations of the air stream at high seped.** I. Imai. *J. Phys. Soc. Japan*, **3**, 342–5 (*Sept.–Dec.*, 1948).

533.6.011.5

**4771. Application of the W.K.B. method to the flow of a compressible fluid. II.** I. Imai and H. Hasimoto. *J. Math. Phys.*, **28**, 205–14 (*Jan.*, 1950).

533.6.011.5 : 518.5

**4772. Graphical, mechanical, and electrical aids for compressible fluid flow.** H. Poritsky, B. E. Sells and C. E. Danforth. *J. Appl. Mech.*, **17**, 37–46 (*March*, 1950).

Rules for the construction of compressible flux plots using wires, beads and a suitable device for obtaining the desired length-width ratios of the rectangles are derived, and the apparatus used is described. An analogy is described by means of which these problems can be solved by the use of a d.-c. resistance board, employing variable resistances which are adjusted to conform to the derived relations. A.

533.6.08 : 536.55

**Vortex thermometer for measuring true air speeds in flight.** *See Abstr.* 4929

## MOLECULAR THEORY OF GASES 533.7

533.7 : 533.16 : 536.633

**4773. Atomic function of some gases in the light of revised viscosity determinations.** V. D. Majmudar and V. S. Oka. *J. Univ. Bombay*, **17**, 35–40 (*March*, 1949).

The viscosities of ethane, carbon dioxide, methane, nitrogen, air, oxygen, hydrogen and neon have been measured near 0°C, with especially high accuracy in order to obtain values for the constant $\varepsilon$, at 0°C, in the relationship $K = \varepsilon\eta C_v$ for gases covering a range of values of $\gamma$, where $\gamma = C_P/C_v$ and $K$, $\gamma$, $C_P$ and $C_v$ are the thermal conductivity, the viscosity and the specific heats respectively. The values for $K$, $C_v$ and $\gamma$ for each gas at 0°C were obtained from standard references. The results are plotted as $\varepsilon$ against $\gamma$, and the nearest straight line gives the relationship: $\varepsilon = (9{\cdot}672\gamma - 5{\cdot}932)/4$. This is compared with similar relationships obtained by other experimenters and by the theoretical predictions of $\varepsilon$. W. H. Denton

533.73 : 536.22

**Thermal accommodation coefficients of gases.** *See Abstr.* 4905–6

## VIBRATIONS . ACOUSTICS 534

534.133 : 537.228.1 : 621.396.611.21 : 621.317.361

**4774. Determination of the natural frequency of vibration of a piezoelectric quartz prism using the circuit and acoustic interferometer of Pierce.** I. Ordoğan. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **12**, 53–79 (*April*, 1947) *In French.*

A detailed description is given of a method whereby the natural frequencies of a quartz crystal can be measured accurately and a study made of the relative amplitudes of vibration of the different crystal faces. For a given crystal, 38 frequencies are recorded in the range 110–900 kc/s. H. J. H. Starks

534.213

**4775. The measurement of the attenuation of a longitudinal wave propagated along a magnetostrictive rod or tube.** F. M. Leslie. *Brit. J. Appl. Phys.*, **1**, 104–6 (*April*, 1950).

A new technique, using the a.c. field set up by a standing wave, is described. Attenuation measurements on two Ni tubes are made and the results compared with figures published elsewhere. The theory underlying the method is developed. A.

534.222.2

**4776. The velocity and structure of very strong shock waves in gases.** W. Döring. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 3–5) 133–50 (1949) *In German.*

Theoretical. If $p_1, p_2$ are the pressures on either side of a one-dimensional shock wave in a homogeneous gas initially at rest, and $\rho_1, \rho_2$ the corresponding gas densities, the ratios $p_2/p_1$ and $\rho_2/\rho_1$ are related by the Hugoniot equation. For a diatomic molecule in which only translational and rotational degrees of freedom are excited, $\rho_2/\rho_1$ increases at first approx. linearly as $p_2/p_1$ increases from unity, tending to a const. value as $p_2/p_1 \to \infty$ ($\rho_2/\rho_1 \to 6$ if $\gamma = 1{\cdot}4$). In very strong shock waves, very high temps. are attained, oscillational degrees of freedom are excited and dissociation and even ionization may occur. The effect of these factors on the Hugoniot relation is discussed qualitatively in general, and the example of $N_2$ is worked out quantitatively in detail; in this case $\rho_2/\rho_1$ rises to a maximum value of 10 to 20 for $p_2/p_1 \simeq 500$ and falls stepwise to approximately 7 as $p_2/p_1 \to \infty$. Because dissociation and ionization are processes requiring a fairly large number of collisions, they do not occur at the shock front, but

ome little distance behind it. It is therefore to be xpected that the temperature in an intense shock wave vill be a maximum near the front of the shock, and vill fall rapidly behind it as energy is absorbed in lissociation and ionization. This may explain xperimental observation of a very narrow zone of high uminosity near the front of an intense shock wave.

A. SCHOFIELD

534.222.2 : 541.126

**4777. The formation of a blast wave by a very ntense explosion. I. Theoretical discussion.** G. AYLOR. *Proc. Roy. Soc. A*, **201**, 159–74 (*March* 22, 950).

An investigation of the motion and pressure of the ir surrounding a point at which a finite amount of nergy is suddenly released. A special feature of he problem is that the energy release is *not* accom-anied by generation of gas. It is found that a pherical shock wave is propagated outwards from he point of energy release. To simplify the analysis, ertain similarity assumptions are introduced: if the adius of the shock wave at any time is $R$ and the ressure at radius $r$ is $p = p_0R^{-3}f(r/R)$, the density $= \rho_0\psi(r/R)$ and the gas-velocity $u = R^{-3/2}\phi(r/R)$, where $p_0, \rho_0$ are the pressure and density of the ndisturbed air, it is assumed that the functions $f, \psi$ and $\phi$ are invariant with time. These assumptions are consistent with conservation of mass and momen-um and with the perfect-gas equation; when the ressure rise across the shock is large they are also onsistent with the Rankine–Hugoniot relation for he shock front. The functions $f, \psi$ and $\phi$ are cal-ulated numerically. The results show that nearly ll the air within the shock-front is compressed into a hin shell just inside that front; the pressure falls apidly through this shell, but remains constant and ppreciable in the low-density core, where the tem-erature is very high. The velocity of the shock-ront decreases as $R^{-3/2}$ and the maximum pressure s $\propto R^{-3}$. Comparison with chemical high ex-losives is limited because for small $R$ the mass of as generated in the explosion is not negligible ompared with the mass of air within the shock, while for large $R$ the pressure rise across the shock ecomes so small that the similarity assumptions are nvalid; in an intermediate range of $R$, where the wo might be expected to be comparable, the heoretical results are borne out by experiment.

A. SCHOFIELD

534.232

**4778. Natural frequencies (partials) of a cylindrical ube closed at both ends and pierced by equal and equi-distant lateral holes.** H. BENEL. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **11**, 47–78 (*July*, 1946) *In French.*

A theoretical paper in which the natural partial frequencies of a tube closed at both ends, and pierced by $n$ equal and equidistant lateral holes (from 1–4) are calculated. The frequencies are dependent on $\phi$ (the ratio of the hole diameter $d$ to the tube diameter $D$) which in the cases considered varies between 0 and 1. The partials obtained can be grouped in systems of multiplets; their multiplicity and their complexity being dependent on the number of holes $n$. The possible partial frequencies are given in a series of tables in which $n$ and $\phi$ vary. A. B. WOOD

534.232

**4779. On the calculation of the sound field of circular membranes in a rigid wall.** H. STENZEL. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 6) 303–24 (1949) *In German.*

534.232

**4780. Work of Soviet acoustical engineers in the study of directional properties of transmitters and receivers.** M. I. KARNOVSKIĬ. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 6) 698–709 (1949) *In Russian.*

Enumeration of results obtained in the investigation of the directionality of various geometrical forms of sound transmitting and receiving surfaces.

W. W. GEHR

534.232

**4781. Development of work on sound focusing.** L. D. ROZENBERG (ROSENBERG). *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 6) 710–16 (1949) *In Russian.*

Historical résumé of the progress of research on sound focusing, from the early iron hemispherical lenses up to the short-focus, concave and convex types as well as elliptical mirrors. W. W. GEHR

534.232

**4782. Theoretical and experimental investigations of the [amplitude of] vibrations and radiation resistance of ultrasonic quartz.** G. BOLZ. *Z. angew. Phys.*, **2** (*No.* 3) 119–27 (1950) *In German.*

Formulae are derived for quartz crystals, one or both sides of which are in contact with a fluid. Measurements of the radiation resistance in $CCl_4$ and $H_2O$ show good agreement with the theoretical values. H. J. H. STARKS

534.321.9

**4783. Powerful acoustic waves.** P. ALEXANDER. *Research, Lond.*, **3**, 68–73 (*Feb.*, 1950).

A summary is given of the present position of ultrasonics, descriptions being given of the piezo-electric and magnetostriction generators and the Pohlmann whistle. The chemical and physicochemical effects of ultrasonic vibrations are ascribed to cavitation or to the accelerations of particles in the sound field, and descriptions are given of the results so far obtained. A. C. WHIFFIN

534.321.9 : 578.088.2

**4784. An ultrasonic wave generator for biological research.** W. S. STUART. *Proc. Leeds Phil. Lit. Soc.*, **5**, 183–9 (*Dec.*, 1948).

534.321.9 : 615.83

**4785. The first symposium on ultrasonics at Erlangen on 2–4 May, 1949.** G. SCHMID AND U. HINTZELMANN. *Naturwissenschaften*, **37** (*No.* 1) 14–20 (1950) *In German.*

Bergmann described the progress which has been made using the ultrasonic pulse technique, and referred to the applications to the determination of the velocity of sound in solids and liquids. The location of objects by the pulse technique was mentioned, Dijkgraaf stating that bats emit between 10 and 170 pulses/sec at a frequency of 30–80 kc/s. Ultrasonic sirens were described, Bergmann referred to an American siren with a power of 35 kW. Various machines for ultrasonic therapy were described and there was discussion as to whether the treatment resulted from the massage produced by the vibration, from the secondary heating, or from cavitation.

The biological effects of ultrasonic vibrations were discussed and a long list was given of the diseases in which ultrasonic therapy has been employed.

A. C. WHIFFIN

534.61

**4786. Absolute acoustical microradiometer.** G. P. Motulevich, I. L. Fabelinskiĭ and L. I. Shteĭngauz. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 29–31 (1950) *In Russian.*

A permanent magnet instrument using a moving coil, deflection of which is prevented by a current through it, is described. The sound pressure is $\propto$ current and the range covered is $10^{-3}$ to $10^{3}$ dynes. Calibration is by a torsion dynamometer.

B. F. KRAUS

534.613

**4787. Radiation pressure in a sound wave.** R. T. Beyer. *Amer. J. Phys.*, **18**, 25–9 (*Jan.*, 1950).

534.83 : 621.395.2

**4788. Telephony and the problem of noise aboard aircraft.** P. Chavasse and R. Lehmann. "*Noise and sound transmission*, 1948" (*Phys. Soc., Lond.*, 1949) 97–109.

Deals with aspects related to human sensitivity. The high noise level inside aircraft ($\sim$ 100 phons) and the amplitude of frequencies $<$ 1 kc/s make severe demands on equipment. Desirable features of components are discussed. The frequency spectra of various machines under different conditions of test have been recorded. Sound-proofing systems should aim at 30 db attenuation. A. J. KENNEDY (R)

534.843

**4789. The intelligibility level as a criterion of the acoustic quality of a room.** A. Moles. *Ann. Télécommun.*, **5**, 57–64 (*Feb.*, 1950) *In French.*

The classical measurements such as reverberation times, on acoustics of rooms, are shown to be insufficient to characterize the room, particularly for its use for speech. Analysis of the various relevant factors shows that the intelligibility level of logatomes at each point in the room gives a more precise measure of its quality. Lists of French logatomes, specially adapted for such tests, are discussed. G. F. HODSMAN

534.844

**4790. Transmission of reverberant sound through double walls.** A. London. *J. Res. Nat. Bur. Stand., Wash.*, **44**, 77–88 (*Jan.*, 1950).

534.844.5 : 534.75

**4791. Development of work on the investigation of optimum reverberation.** S. Ya. Lifshits. *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **13** (*No.* 6) 640–4 (1949) *In Russian.*

Brief review of work on architectural acoustics, leading to recent physiological study of monoaural audibility. W. W. GEHR

## OPTICS . RADIATION . SPECTRA 535

535.13

**4792. Application of Huyghens' principle in a space containing two optical media; expressions for the reflected and refracted waves.** J. Brodin. *C.R. Acad. Sci., Paris*, **230**, 67–9 (*Jan.* 2, 1950) *In French.*

A homogeneous medium of finite extent is surrounded by a second homogeneous medium, of infinite extent, containing a harmonic source. The media are non-magnetic and have arbitrary permittivities, which, owing to conduction, may be complex. It is found possible to specify an electric and a magnetic dipole sheet (coincident with the interface) from which the fields in the two media may be found by two calculations in each of which the whole of space may be regarded as homogeneous.

P. M. DAVIDSON

535.2223

**4793. Velocity of light.** E. Bergstrand. Letter in *Nature, Lond.*, **165**, 405 (*March* 11, 1950).

The value of 299 796 $\pm$ 2 km/s previously published [Abstr. 5315 (1949)] is corrected to 299 793 $\pm$ 2 km/s; and new measurements give a result 299 792·7 $\pm$ 0·25 km/s. This is compared with the value of 299 792 km/s obtained by Essen and Gordon-Smith and by Aslakson. L. ESSEN

535.222

**4794. Velocity of light and of radio waves.** L. Essen. *Nature, Lond.*, **165**, 582–3 (*April* 15, 1950).

Reviews of the values of the physical constants gives the most probable value as 299 776 $\pm$ 4 km/s, but this is not supported by a number of recent determinations. Measurements with a cavity resonator, at the N.P.L., gave 299 792 km/s, which has now been confirmed there by a further resonator experiment, and is also supported by the results of a Shoran radar method described by Aslakson. The Kerr cell optical method has been improved by Bergstrand, whose latest value is 299 792·7 $\pm$ 0·25 km/s.

L. ESSEN

535.23.08

**4795. On the limits of the response of detectors of radiation.** R. W. Pohl and F. Stöckmann. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 199–200 (1948) *In German.*

The minimum energy which can be registered by a detector of radiation is inversely $\propto$ the exposure time $t$, which can be increased by summation in some instances. For the light-adapted eye $t \simeq 0{\cdot}05$, for the dark-adapted eye $\simeq 0{\cdot}5$ sec; these are the limiting times for which the energy of stimulation is constant. $t = 0{\cdot}5$ sec corresponds to two quanta per minute. But 6 000 quanta per minute are required for stimulation as found by experiment. This large number is thought to eliminate the observation of quantum fluctuations. R. A. WEALE

535.23.08 : 621.317.78.029.6 : 621.317.733

**4796. Analysis of the direct-current bolometer bridge.** D. M. Kerns. *J. Res. Nat. Bur. Stand., Wash.*, **43**, 581–9 (*Dec.*, 1949).

The behaviour of a d.c. Wheatstone bridge with a non-linear element (bolometer) in one arm, as used in the measurement of microwave power, is analysed. Results of general applicability are obtained by ascribing arbitrary values to the resistances comprising the bridge-network and by employing a resistance law of a general form for the bolometer element. Emphasis is placed upon the development of first-order theory in convenient form. General

aracteristics of this type of network (and non-ıear element) are indicated. Results obtained clude an expression for the derivatives of galvano-eter current with respect to r.f. power, ambient mperature, source-voltage, and source-resistance. A.

535.231.4 : 621.365.4

**'97. Radiation measurements on heating elements the spectral region 0·5–7 μ.** J. EULER. *Elektrotech.* [*ETZ*] **70,** 427–31 (*Nov.* 1, 1949) *In German.*

The emissivities, the angular and spectral distri-ıtions of emitted energy, and the dependence of ›sorptivity and directional distribution of energy ı the amount of scale present, have been measured tween 700 and 1 400° C for a number of strongly ıidized alloys. These were of 4 kinds: CrNi, CrNi–eel with large Ni content, CrNi–steel with small Ni ntent, and Al–steel free from Ni. The results are own graphically. Although the specimens were itially oxidized to different extents and with very fferent emissivities, after use for a time which was pendent on the temp. only, the emissivities rose to constant value of between 80 to 97%. The spectral ıriation of emissivity was small. In the final state e angular distribution of radiation was approxi-ately in accordance with Lambert's cosine law.

S. WEINTROUB (R)

535.233

**'98. The 1949 scale of color temperature.** D. B. JDD. *J. Res. Nat. Bur. Stand., Wash.,* **44,** 1–8 *an.*, 1950).

Because of the revision of the International Tem-ırature Scale to use the Planck radiation formula stead of the Wien, with a new value assigned to the nstant $c_2$, the scale of colour temperature in use at e N.B.S. since 1934 has been revised. The details this revision are given, and the results are sum-arized in a table showing the conversion of colour mperature on the 1934 scale to that on the present, 1949, scale. The use of lamp standards of colour mperature to obtain known spectral distributions radiant flux between 380 and 770 millimicrons is scussed, and comparisons are made between the 22 scale of colour temperature and the 1934 and 49 scales for this purpose. A.

535.243

**'99. Slit-width effects in spectrophotometry.** . H. EBERHARDT. *J. Opt. Soc. Amer.,* **40,** 172–6 *Aarch*, 1950).

A technique is suggested which allows an estimate be made of the errors introduced into spectro-ıotometric measurements by the use of slits of finite dth. The technique depends upon approximate ıalytic expressions for the slit function, the variation the instrument sensitivity with wavelength, and the riation of the absorption coefficient with wave-ıgth. A slit function is suggested for use with ectrophotometers with entrance and exit slits of ual width but with optics of varying dispersion. pressions are derived for two convenient approxima-›ns for the absorption coefficient in the neighbour-›od of a maximum: a parabolic form, and two ersecting straight lines of opposite slope. Applica-›n of these expressions is made to experimental data solutions of benzene, oxyhemoglobin, and neo-mium chloride. A.

535.245.24

**4800. Polar diagrams of luminous flux distribution.** V. GIAMBALVO. *Elettrotecnica,* **37,** 68–70 (*Feb.*, 1950) *In Italian.*

Polar diagrams can be constructed in which the area in any zone is $\propto$ the flux emitted from the source in that zone, for sources for which the relation between luminous intensity and angle of emission is a simple one. The diagrams for $I = \text{const.}$, $I = I_n \sin \alpha$ and $I = I_m \cos \alpha$ are illustrated. J. W. T. WALSH

535.247.4 : 535.33

**4801. A contour photometer.** H. W. BABCOCK. *Publ. Astr. Soc. Pacif.,* **62,** 18–21 (*Feb.*, 1950).

The moving spot of an oscilloscope with a short-persistence tube is made to scan a rectangular area. This spot is focused on to the photographic negative whose contour is required, the transmitted light being focused by a field lens on to the cathode of a photo-multiplier tube. The output of the photomultiplier, after d.c. amplification, intensifies the electron beam of a second oscilloscope (the contour reproducer), which is synchronized with the scanning tube, whenever the transmitted intensity surpasses a preselected level. The sensitivity is adjusted by varying the load-resistance of the photomultiplier. The contour given by the contour reproducer is recorded photographically. M. W. OVENDEN

535.31

**4802. Matrices and the theory of optical instruments. I. The fundamental equations of geometrical optics in matrix form.** T. SMITH. *An. Real. Soc. Esp. Fis. y Quim.*, **45A,** 301–14 (*July–Aug.*, 1949) *In Spanish.*

535.312.2

**4803. Optical and geometrical considerations on inclined mirrors.** E. LAU AND W. KRUG. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 3–4) 161–8 (1948) *In German.*

The theory of image formation for triple mirrors is developed. In the first instance the case of 3 perpendicular mirrors forming the corner of a cube is analysed. Relationships between real and virtual images are discussed. It is shown that if the plane mirrors in a Michelson interferometer are replaced by the mirror combination under discussion, then the interference system is maintained with a much greater ease in adjustment. Geometrical deductions from the mirror arrangements permit of proposing a method for the technical manufacture of spherical surfaces.

S. TOLANSKY

535.314

**4804. Theory of reflection and refraction.** C. SCHAEFER AND C. V. FRAGSTEIN. *Ann. Phys., Lpz.,* **6,** 39–43 (1949) *In German.*

When a beam of light undergoes total reflection, theory predicts a small lateral displacement of the reflected beam [*Ann. Phys., Lpz.* (*Folge* 5) **3** (*No.* 4) 433 (1929); *ibid.*, **30** (*No.* 3) 245 (1937)]. The treatment has now been extended to show that the effect is not confined to the case of total reflection; it should occur, though usually in much lesser degree, at all reflections from an absorbing medium.

P. M. DAVIDSON

535.317

**4805. Wave-front aberrations of oblique pencils in a symmetrical optical system: refraction and transfer formulae.** W. WEINSTEIN. — *Proc. Phys. Soc., Lond. A*, **63**, 221 (*March*, 1950). Errata to Abstr. 828 (1950).

535.317.4

**4806. Chromatic variation of spherical aberration.** W. WEINSTEIN. *Brit. J. Appl. Phys.*, **1**, 67–73 (*March*, 1950).

Formulae are given for chromatic variation of spherical aberration in an optical system, (*a*) considered surface by surface, (*b*) considered as a collection of separated thin lenses. A.

535.317.5

**4807. A coherent set of tolerances for geometrical aberrations, including excentration effects.** A. MARECHAL. Letter in *J. Opt. Soc. Amer.*, **40**, 60 (*Jan.*, 1950).

The loss of illumination at the centre of the diffraction pattern (Airy disc) is given in terms of the mean square error of wavefront $E_0$ [Abstr. 3462 (1947)]. Applying the Rayleigh limit for third-order aberrations enables a tolerance to be laid down in terms of $E_0$, when these aberrations are present singly or in combination. This path difference method is also applicable to excentration errors, and the tolerance is calculated for a typical microscope objective with excentric components. R. W. FISH

535.32

**4808. The sideways displacement of totally reflected light.** C. v. FRAGSTEIN. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 5) 271–8 (1949) *In German.*

The previously observed sideways displacement which occurs at total reflection [Abstr. 1822 (1947)] is discussed theoretically. An approximate solution to Maxwell's equations is used. As in the theory given by Artmann [Abstr. 3217 (1948)] a polarization dependence is found which has so far not been found experimentally. S. TOLANSKY

535.32

**4809. A new measurement of the displacement of the beam at total reflection.** F. GOOS AND H. LINDBERG-HÄNCHEN. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 3–5) 251–2 (1949) *In German.*

Earlier measurements are repeated with a plane-parallel glass plate of high refractive index. At grazing total reflection 68 to-fro beams were operative. In accordance with theory the polarization effect increases with the square of the refractive index. The observed polarization is in good agreement with the theory developed by Artmann [Abstr. 3217 (1948)]. S. TOLANSKY

535.322.4

**4810. A precision refractometer for measurements at constant temperature.** A. WINTER-KLEIN. *Rev. Opt.* (*Théor. Instrum.*) **29**, 141–50 (*March*, 1950) *In French.*

This modification of the Pulfrich refractometer uses a reference prism of different shape, and also two light sources, to eliminate errors arising from non-parallelism of test piece and reference prism. Indices can be measured with an accuracy of $1\times10^{-5}$ over the entire range of index 1·40–1·92, by the use of 3 reference prisms. The instrument is totally enclosed, electrically heated and thermostatically controlled at a temperature of 30 ± 0·25° C. R. W. FI

535.33

**4811. Separation of radiations in the near infrar by means of prisms. I. Dispersion of some optic glasses.** J. LECOMTE. *J. Phys. Radium*, **11**, 7– (*Jan.*, 1950) *In French.*

Reports measurements of refractive index betwee 0·4 and 2·4 $\mu$, using a Wadsworth spectrometer an known absorption bands; results are considere accurate to some units in the fourth decimal. Vario formulae to fit the results are considered, the mo useful being $\mu^2 = \mu_0^2 + A/(\lambda^2 - \lambda_0^2) - e\lambda^2 - f\lambda^4$; f some glasses the last term can be ignored. In no ca is it reliable to extrapolate measurements belo 0·9 $\mu$ only. G. F. LOTHIA

535.32

**4812. A method of measuring the refractive inde of liquids.** E. G. KNOWLES. *Brit. J. Appl. Phys.*, 133–4 (*May*, 1950).

A glass prism has one face immersed in the liquic the emergent angle of rays refracted at the critica angle being observed in a telescope with graticul An empirical calibration is made by using two liquic of known refractive index, the interpolated curv being straight. The advantages of the instrumen are its simplicity and passivity to reactive liquids.

535.32

**4813. On the refraction and dispersion of the nobl gases krypton and xenon.** J. KOCH. *K. Fysiogr Sällsk. Lund, Förh.*, **19** (*No.* 13) 173–87 (1949).

The refractive indices for Kr and Xe were measure by an interferometer method between $\lambda = 2\,302$ and 6 236 Å and agree with those calculated from th wave mechanics dispersion formula within $5\times10^{-8}$ It is concluded that the assumed resonance frequencie are correct, and that the distribution of refractivity between discrete and continuous spectra is about 1 : 3 for each gas. N. CORCORAN

535.33

**4814. On line emission from the inhomogeneous layer. I.** H. BARTELS. *Z. Phys.*, **125** (*No.* 7–10) 597–614 (1949) *In German.*

The contour of a line emitted from an inhomogeneous layer is determined by the layer thickness, the line form and the course of the abundance and absorption coefficient within the layer. When the optical layer thickness grows without change in the relative distribution of the abundance and absorption coefficient it is shown that, with the frequency held constant, the layer thickness already passes through a maximum for finite layer thickness, afterwards to drop asymptotically to the boundary value of the abundance. In its effect on the relationship between ray thickness and optical layer thickness the great diversity and the relative distribution of the abundance and absorption coefficient can be described by a single parameter with an approximation utilizable for considerable layer thicknesses. The theory of the contour is built up on the relationship between ray thickness and optical layer thickness with the aid of the frequency-dependence of the optical layer thickness within the line. It is developed on the

ssumption that the line form does not change in the ight source. H. G. SOLOMON

535.33

**4815. The derivation of vacuum wave numbers and he reduction of measured wave lengths to standard tmospheric conditions.** H. D. BABCOCK. *Astro-hys. J.*, **111**, 60–4 (*Jan.*, 1950).

Tables are constructed from the data of Barrell nd Sears for reducing wavelengths observed under on-standard conditions to their values at 760 mm nd 15°C. The new tables are compared with those f Meggers and Peters. A.

535.33

**4816. Retrogression in spectroscopy.** G. R. HARRISON. *J. Opt. Soc. Amer.*, **40**, 127–34 (*March*, 950). A review of the author's work. 95 refs.

535.33

**4817. Comment on "Spark spectra of elements 43 nd 61."** C. C. KIESS. Letter in *J. Opt. Soc. Amer.*, **0**, 177 (*March*, 1950). See Abstr. 2320 (1950).

535.33–15

**4818. Infrared spectrometry of small samples with he reflecting microscope.** R. C. GORE. *Science*, **110**, 10–11 (*Dec.* 30, 1949).

A reflecting microscope and infrared spectrometer ombination has been used by Barer, Cole and Thompson [Abstr. 1854 (1949)]. The object of the present paper is to try American reflecting micro-copes in this connection. The Bausch and Lomb Type V apochromatic reflecting miscroscope has a imited frequency range (u.v. to 2 500 $cm^{-1}$) because f the refraction elements included. The Bausch nd Lomb Type IV, 0·4 N.A. condenser and objectives ses reflectors only and allowed a wider range to be sed. It was introduced as part of an auxiliary ondenser system to project an enlarged image of the pecimen on to the entrance slit of a Perkin–Elmer nfrared spectrometer. A record is shown of the bsorption spectrum of sodium benzyl penicillin. Owing to the need for increasing width of slit, the stimated mass of the sample used varied from 0·3 $\mu$g at 4 000 $cm^{-1}$ to 3 $\mu$g at 650 $cm^{-1}$.

A. C. MENZIES

535.33.03

**4819. A d.c. arc source and automatic controller.** G. H. FETTERLEY AND W. M. HAZEL. *J. Opt. Soc. Amer.*, **40**, 76–9 (*Feb.*, 1950).

An effective source of d.c. having any desired output up to 45 A at 150 V is described. An automatic current controller is also described as a separate unit, and can be used to hold the current within ±0·5 A at any selected value between 5 and 15 A. A.

535.33.03 : 545.82

**4820. A new source for spectro-chemical analysis.** L. G. ROUSE. *J. Opt. Soc. Amer.*, **40**, 82–4 (*Feb.*, 1950).

An induction heater is used to evaporate the sample field in a C cup, and the vapour is then excited by a spark. The two main functions of a source, evaporation and excitation, are thus separately controlled. A study of the boiling point temperature of the sample can be used to differentiate elements and compounds. A.

535.33.072

**4821. On the effect of slit dimensions on collimated beam intensity.** L. GOLD. Letter in *J. Opt. Soc. Amer.*, **40**, 119–20 (*Feb.*, 1950).

535.33.072–15

**4822. Synthetic $SiO_2$ prism in the infra-red.** M. DAVIES. Letter in *J. Chem. Phys.*, **18**, 398 (*March*, 1950).

535.331

**4823. Structure and new energy levels of the arc spectrum of manganese.** O. G. RIQUELME. *An. Real Soc. Esp. Fis. y Quim.*, **45A**, 435–48 (*Sept.–Oct.*, 1949) *In Spanish.*

The previous lists of levels and terms have been reviewed and increased with 58 new levels, some of which are arranged into 15 terms. So far 200 lines have been classified with the aid of these levels. Rydberg denominators obtained for the electrons *ns*, *nd*, 4*p* are given. The groups of quartets, arising from triplet limits in Mn II, belonging to the configuration $3d^6 4s$ have been found. A sextet term of $3d^6 4d$ and some of the sextets and quartets terms from quintets limits of $3d^5 4s 4p$ have also been found. The classified wavelength table contains all the lines classified up to date. The general table of levels and multiplets arising from the new terms is also included. A.

535.331

**4824. Cadmium spectra.** K. C. MAZUMDER; A. G. SHENSTONE. Letters in *J. Opt. Soc. Amer.*, **40**, 120–1 (*Feb.*, 1950).

Mazumder points out that he had already published [Abstr. 1311 (1944)] results given by Shenstone and Pittenger [Abstr. 3083 (1949)]. Shenstone replies that some of Mazumder's levels do not exist.

535.332

**4825. A new type of fine structure in the spectrum of Ne II.** S. SUWA. *J. Phys. Soc. Japan*, **4** (*No.* 3) 179 (*March–April*, 1949).

535.333

**4826. On the emission bands of $CF_2$.** P. VENKATESWARLU. *Phys. Rev.*, **77**, 676–80 (*March* 1, 1950).

A new band system attributed to a non-linear $CF_2$ molecule has been obtained by exciting the flowing vapour of $CF_4$. The symmetric stretching frequencies and the bending frequencies in the lower and upper states have been determined. From a study of the sub-band heads (*K*-structure), it is shown that the band system is of the parallel type, that is, the electric moment associated with the transition vibrates parallel to the line joining the fluorine atoms. The band system is identified with the transition $^1B_2 \rightarrow {}^1A_1$. A.

535.337 : 537.228.5

**4827. The Stark-effect in the Balmer series of hydrogen at low field-strengths.** W. STEUBING AND W. JUNGE. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 108–16 (1949) *In German.*

Studies of the lines $H\beta$ and $H_\gamma$ show that the Stark-splitting varies linearly with the field-strength in the range 5 000–20 000 V/cm. However, the effect vanishes at about 2 000 V/cm, and varies approximately as the

second power of the field-strength in the range 2 000–5 000 V/cm [see Abstr. 5328 (1949)].

R. F. BARROW

535.338.333 : 539.152.2

**4828. Nuclear spin and isotope shift of xenon investigated with separated isotopes.** J. KOCH AND E. RASMUSSEN. Letter in *Phys. Rev.*, **77**, 722 (*March* 1, 1950).

535.338.334 : 536.5

**4829. Determination of very high temperatures from the breadth of spectral lines.** P. SCHULZ. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 280–8 (1948) *In German.*

The broadening of excited atomic levels caused by the near approach of electrons or ions is considered. For certain terms it is approximately proportional to the concentration of electrons. Thus measurement of the line-breadth and application of Saha's equation enables the temperature to be determined. The method is supported by the results of measurements on the lines Hg 5770/91 and 10 140 Å excited in a high-pressure arc.

R. F. BARROW

535.338.4

**4830. Emission spectra of the manganese halides.** P. TIRUVENGANNA RAO. *Indian J. Phys.*, **23**, 517–24 (*Dec.*, 1949).

Bacher's analysis [Abstr. 6081 (1949)] of the MnCl bands in the region $\lambda$3900–$\lambda$3500, as arising from the electronic transition $^7\Pi$–$^7\Sigma$, is extended to the higher sequences $\Delta v = \pm 1, \pm 2, \pm 3$. A similar analysis is worked out for the $\Delta v = +1$ sequence of MnBr bands. A.

535.338.4

**4831. The complex band spectrum of titanium chloride. (The diatomic molecule, TiCl.)** V. RAMAKRISHNA RAO. *Indian J. Phys.*, **23**, 535–46 (*Dec.*, 1949).

The characteristic band spectrum of TiCl has been obtained in a transformer discharge through the vapour. The bands are divided into two systems, from $\lambda$4206–4031 and $\lambda$4072–3787, which are analysed on the assumption of the respective electronic transitions $^4\Pi$–$^4\Sigma$ and $\Sigma^4$–$^4\Sigma$. The approximate vibrational constants are given. A.

535.338.4

**4832. Band spectrum of $CO^+$. I. First negative system ($B^2\Sigma - X^2\Sigma$).** K. NARAHARI RAO. *Astrophys. J.*, **111**, 50–9 (*Jan.*, 1950).

Revised values for the molecular constants of the two electronic states are obtained. A.

535.338.4

**4833. Emission of dilute oxygen in an atmosphere of xenon.** R. HERMAN AND L. HERMAN. *J. Phys. Radium*, **11**, 69–76 (*Feb.*, 1950) *In French.*

Spectra of discharges and phosphorescence show unusual bands of $O_2$ and lines of O I. A vibrational analysis is given for bands in the green associated with the O I auroral line 5 577 Å. Diffuse bands below 2 430 Å and bands near 2 620, 2 930, 3 080, 3 150 and 3 660 are described. Excitation processes are discussed; recombination of metastable neutral O atoms, or reactions of O and Xe atoms may be important.

A. G. GAYDON

535.338.4 : 539.13 : 539.152.1

**4834. The rotational structure of the band-spectrum of $S_2$.** S. M. NAUDÉ. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 201–22 (1948) *In German.*

Detailed rotational analyses of the following bands are given: 1,14, 2,17, 3,17, 3,19, 4,19, 4,22, 5,22, 5,23, 6,23, 6,25, 7,25, 7,27, 8,27. The more important derived constants are: $B_v'' = 0{\cdot}2956 - 0{\cdot}001\epsilon (v + \frac{1}{2})$, $B_v' = 0{\cdot}2219 - 0{\cdot}0018 \quad (v + \frac{1}{2})$, $r_e'' = 1{\cdot}893$ Å. [See also Naudé, *S. Afr. J. Sci.*, **41**, 128 (1945) and Abstr. 2239 (1945)]. R. F. BARROW

535.339

**4835. A projected concave grating monochromator with oblique incidence, for the far ultraviolet.** M. SALLE AND B. VODAR. *C.R. Acad. Sci., Paris*, **230**, 380–2 (*Jan.* 23, 1950) *In French.*

An instrument is being constructed with a 3 m grating having 570 lines/mm. Source S and grating R, rigidly connected, are moved on the Rowland circle by sliding along SS′ and RS′ which are at a fixed angle apart—S′ being the exit slit. Dispersion at the slit is 0·17 mm/Å. G. F. LOTHIAN

535.34.072–14

**4836. The design and construction of a Stark-modulation microwave spectrograph.** A. H. SHARBAUGH. *Rev. Sci. Instrum.*, **21**, 120–35 (*Feb.*, 1950).

Circuit diagrams and values of the components are given. The frequency range is from 17 000 to 28 000 Mc/s. Peak Stark-modulation voltages up to 1 500 V sine wave and 800 V square wave are used. The sensitivity is better than $1 \times 10^{-8}$ cm$^{-1}$. The absorption lines are about 300 kc/s wide at half-power and the practical limit of resolution is between ½ and 1 Mc/s. Frequencies may be measured to better than ± 0·08 Mc/s. A.

535.343–14

**4837. Microwave spectra and molecular constants of trifluorosilane derivatives. $SiF_3H$, $SiF_3CH_3$, $SiF_3Cl$, and $SiF_3Br$.** J. SHERIDAN AND W. GORDY. Letter in *Phys. Rev.*, **77**, 719 (*March* 1, 1950).

535.343.2

**4838. Pressure and temperature shift of the absorption edge of cadmium sulphide.** G. HÖHLER. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 7) 371–8 (1949) *In German.*

An attempt to decide between alternative explanations of the temperature shift, either that it is due to change of lattice constants with temperature (Möglich and Rompe), or to broadening with temperature rise of the lower terms in the conduction band (Radkovsky). The transmission spectrum of small CdS crystals was measured isothermally under oil pressure up to 300 atmos., and the absorption edge shift caused by lattice contraction found to be 0·02 Å towards the blue per atmos. increase. By calculation this corresponds to ~ 0·25 Å towards the red per 1°C rise, compared with ~ 1 Å/1°C observed. From this and other calculations it is concluded that both mechanisms are concerned in the shift, but that only ⅛ of the effect is due to change of lattice dimensions.

S. T. HENDERSON

535.343.2

**4839. Analysis of the absorption bands of the uranyl salts.** D. D. PANT. *Proc. Indian Acad. Sci. A*, **31**, 35–41 (*Jan.*, 1950).

The absorption spectra of several uranyl salts have

been interpreted. Most of the bands arise out of the two closely spaced levels except for one series which rises from about 220 above the ground state. In view of the high transition probability for this series, its existence is shown to be justified. The necessity of using much higher levels (as high as 2 000 as done by earlier workers) does not arise. A.

535.343.2

**4840. Infra-red absorption in silicon.** H. B. BRIGGS. Letter in *Phys. Rev.*, **77**, 728–9 (*March* 1, 1950).

535.343.2–15

**4841. The infra-red spectrum of magnesium oxide.** C. C. WILLMOTT. *Proc. Phys. Soc., Lond. A*, **63**, 389–402 (*April*, 1950).

An investigation of the infrared spectrum of MgO has been carried out in the range up to 25·5 $\mu$, both by reflection and transmission. The eigenfrequency is found to be at 17·5 ± 0·3 $\mu$ and 4 subsidiary maxima have been found in transmission. The results of Barnes, Brattain and Seitz [*Phys. Rev.*, **48**, 582 (1935)] in the range up to 15·6 $\mu$ have not been confirmed and no detailed fine structure has been found. The reflection spectrum has been fully investigated up to 25·5 $\mu$, and a broad reflection maximum has been found extending from 17 $\mu$ to 21 $\mu$, with subsidiary maxima at 14·02 $\mu$ and 23·8 $\mu$. From the data obtained curves have been drawn to show the behaviour of the optical constants $n$ and $k$ in the range from 7 $\mu$ to 25 $\mu$. A.

535.343.3

**4842. Further observations on absorption spectra at low temperatures.** D. KEILIN AND E. F. HARTREE. *Nature, Lond.*, **165**, 504–5 (*April* 1, 1950).

Experiments are described which support the view [Keilin and Hartree, *Nature, Lond.*, **164**, 254 (1949)] that the intensification of some absorption spectra observed on cooling to liquid-air temperature arises largely from an increase in the effective optical path when the solvent changes from a glass to a crystalline mass. R. F. BARROW

535.343.3–15

**4843. The infrared spectra and structures of the iron carbonyls.** R. K. SHELINE AND K. S. PITZER. *J. Amer. Chem. Soc.*, **72**, 1107–12 (*March*, 1950).

Infrared spectra in the region 2–23 $\mu$ are reported for $Fe(CO)_5$ and $Fe_2(CO)_9$. Some frequency assignments are made. The data on $Fe(CO)_5$ are fully consistent with the reported trigonal bipyramid structure. The spectrum of $Fe_2(CO)_9$ was obtained only for the solid and is relatively meagre. However, the bridged structure involving ketone-like carbonyl groups is strongly supported by the observation of a strong band at I 828 $cm^{-1}$ in addition to the usual metal carbonyl C–O frequencies near 2 000 $cm^{-1}$. The implications of the results in terms of bond types are discussed briefly. A.

535.343.3–15

**4844. Azobenzene. II. Infra-red spectra of slurries of *cis*- and *trans*-azobenzene.** K. S. TETLOW. *Research, Lond.*, **3**, 187–8 (*April*, 1950).

535.343.3/4 : 539.13

**4845. Absorption spectrum of oxygen.** D. KEILIN AND E. F. HARTREE. *Nature, Lond.*, **165**, 543–4 (*April* 8, 1950).

Previous work on the visible absorption bands of oxygen is reviewed, and new observations on the $O_4$ bands at 6 310, 5 770, 5 320 and 4 775 Å are reported. The 5 770 band has been detected in gaseous O in the laboratory, under conditions agreeing with the predictions of Janssen's law, intensity = constant × path length × (pressure)$^2$. [Janssen, *C.R. Acad. Sci., Paris*, **120**, 1306 (1895)]. Values of the extinction coefficient of liquid oxygen are given for the range 4 750–6 500 Å. [See also Keilin and Hartree, *Nature, Lond.*, **164**, 254 (1949)]. R. F. BARROW

535.343.4

**4846. The absorption spectrum and the dissociation of $H_2O_2$.** R. EDSE. *J. Chem. Phys.*, **18**, 244–5 (*March*, 1950).

535.343.4–14

**4847. Temperature dependence of microwave line widths.** R. HOWARD AND W. V. SMITH. *Phys. Rev.*, 77, 840–1 (*March* 15, 1950).

535.343.4–15

**4848. The infrared spectra of two bromine derivatives of ethane.** J. R. BARCELÓ. *An. Real Soc. Esp. Fis. y Quim.*, **45A**, 315–28 (*July–Aug.*, 1949) *In Spanish.*

535.343.4–15

**4849. The infrared spectra of two fluorine derivatives of ethylene.** J. R. BARCELÓ. *An. Real Soc. Esp. Fis. y Quim.*, **45A**, 449–56 (*Sept.–Oct.*, 1949) *In Spanish.*

The i.r. absorption spectra of the tetrafluoroethylene and the asymmetric difluoroethylene are studied in the gaseous state from 2 $\mu$ to 40 $\mu$ using successively LiF, NaCl, KBr and KRS5 prisms. A.

535.343.4–15

**4850. Rotation-vibration spectra of diatomic and simple polyatomic molecules with long absorbing paths. III. The spectrum of cyclopropane ($C_3H_6$) from 2·3 to 0·6 $\mu$.** S. P. SINHA. *J. Chem. Phys.*, **18**, 217–22 (*Feb.*, 1950).

The absorption spectrum of $C_3H_6$ has been investigated in the region 1·2 to 2·3 $\mu$ with absorbing paths up to 1 760 m. A large number of overtone and combination bands, about 150, have been found. Provisional vibrational assignments of nearly all the strong bands from 2·3 to 1·3 $\mu$ are given. For the weaker bands no unique assignments are possible. The parallel band at 10 970 Å has been resolved and its rotational structure has been analysed. The moment of inertia in the lower state is found to have the value $I_B = 42{\cdot}1_5 \times 10^{-40}$ g cm$^2$. A.

535.343.4–31

**4851. An ultra-violet band-system of $CS_2$.** R. K. LAIRD AND R. F. BARROW. Letter in *Proc. Phys. Soc., Lond. A*, 63, 412 (*April*, 1950).

535.352 : 535.338.4

**4852. On the abnormal intensity distribution in the OH band.** M. NINOMIYA. *J. Phys. Soc. Japan*, **4**, 275–9 (*July–Dec.*, 1949).

Intensity measurements of rotational lines of the OH and OD bands are reported. It is concluded that the excitation processes are: (1) $H_2O \xrightarrow{e} H_2O^*(^1A_1) \rightarrow$

$OH^*(^2\Sigma) + H$; (2) $OH(^2\Pi) \xrightarrow{e} OH^*(^2\Sigma)$. These processes change in relative importance with varying experimental conditions. The anomalous intensity distributions arise from (1). [See also Abstr. 4853 (1950)]. R. F. BARROW

535.352 : 539.13

**4853. On the excitation of $H_2O$ molecules by fast electrons.** K. NIIRA. *J. Phys. Soc. Japan*, **4**, 230–3 (*July–Dec.*, 1949).

The results are given of theoretical calculations of the probabilities of excitation, by collision with electrons of varying energy, of two unstable states of $H_2O$ which dissociate into H and $OH(^2\Sigma^+)$. [See also Abstr. 4852 (1950)]. R. F. BARROW

535.37

**4854. Influence of temperature on the duration of the luminescence of fluorescein solutions.** M. D. GALANIN. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 6) 989–90 (1950) *In Russian.*

535.37

**4855. On scattering and absorption of the luminescence in polycrystalline phosphor layers excited by high energy quantum and corpuscular rays.** I. BROSER. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 6–8) 401–16 (1950) *In German.*

Screens of ZnS . Cu under $\alpha$-particles, $\gamma$-rays or X-rays were used to determine the variation of light output with thickness, both on the irradiated side and on the other. The results agreed with calculations taking into account the absorption, scattering and transmission of light in the layers and the different distribution of excitation for the three radiations. The scattering and absorption constants are independent of the type of excitation, but change of grain size in the screen produces marked differences in the light output. S. T. HENDERSON

535.37

**4856. Effect of temperature on the momentary illumination of phosphorescent sulphides under electric fields.** G. DESTRIAU. *C.R. Acad. Sci., Paris*, **230**, 205–6 (*Jan.* 9, 1950) *In French.*

Some Zn sulphides previously irradiated with X-rays show a fleeting illumination when submitted to an alternating field. Mattler and the author have shown that the light sum thus emitted is a function of the dosage and the time elapsing between dosage and application of field [Abstr. 2849 (1947)]. Examination of the curves showing the light sum for different values of time interval dosage and temperature show that: (1) the position of the maximum is reached for lower values of dose as the temperature is increased; (2) the effect increases up to about 35°c and then decreases; (3) the position of the maximum is independent of the time interval between dosage and field application. The course of the curves is accounted for by a deactivating photoelectric effect of the X-rays. J. EWLES

535.37

**4857. Visible red photoluminescence of cadmium sulphide.** E. GRILLOT. *C.R. Acad. Sci,, Paris*, **230**, 1159–61 (*March* 20, 1950) *In French*

The preparation of samples of CdS(Ag) which show luminescence of wavelength as low as 6 150 Å is described. R. F. BARROW

535.37 : 537.542

**4858. Excitation of luminescence in cadmium sulphide crystals by α-particles and electrons.** H. KALLMANN AND R. WARMINSKY. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 1–2) 57–60 (1948) *In German.*

Studies were made of luminescence in large crystals of CdS due to $\alpha$- and $\beta$-particles. Ag-activated crystals have intense red emission (max. 7 500 Å) with high efficiency similar to that of ZnS–Ag (19%). Without Ag-activation luminescence is weak. Decay times for emission of CdS–Ag are about $2 \times 10^{-4}$ sec (ZnS–Ag: $< 10^{-5}$ sec). Internal reflection causes light to leave crystals at edges. Strongly luminescent crystals exhibit good photoconductivity. G. F. J. GARLICK

535.37 : 548.0 : 537.228

**4859. Semi-permanent modification of the properties of certain crystals by an alternating electric field.** G. DESTRIAU. *C.R. Acad. Sci., Paris*, **230**, 1061–2 (*March* 13, 1950) *In French.*

Irradiation of CdS, ZnS, or mixed phosphors by X-radiation and simultaneous application of the electric field produced marked variation in brilliances particularly in the first two min. following the application of the field. Presumably changes in the electronic configuration of the crystals are brought about. W. R. ANGUS

535.371

**4860. Errata: The luminescence of photo-conducting phosphors.** G. F. J. GARLICK AND A. F. GIBSON. *J. Opt. Soc. Amer.*, **40**, 79 (*Feb.*, 1950).

See Abstr. 2357 (1950).

535.371 : 537.312.5

**4861. Luminescence and photoconduction of cadmium sulphide.** D. V. GUREVICH, N. A. TOLSTOĬ AND P. P. FEOFILOV. *Dokl. Akad. Nauk, SSSR*, **71** (*No.* 1) 29–32 (1950) *In Russian*

Results are given of an investigation of the kinetics of luminescence and photoconduction in connection with previous work on the relaxation of photoconduction in semi-conductors; Gurevich, Tolstoi and Feofilov [Abstr. 3160 (1950)]; Gurevich [Abstr. 4989 (1950)]. The investigation has been carried out on CdS monocrystals. It has been found from experiments that the momentary brightness of luminescence $I \sim E/(1 + at)^\alpha$ where $E$ is the intensity of the exciting light and $a \sim \sqrt{E}$, while the momentary value of photoconduction $\Delta\sigma \sim E/(1 + bt)^\beta$ where $b \sim \sqrt{E}$. The magnitudes $\alpha$ and $\beta$ do not depend upon illumination. It has been calculated that the law of the decrease of the light sum of phosphorescence $L(t) \sim \sqrt{(E)}/(1 + at)^{\alpha-1}$ coincides with the law of the decrease of photoconduction. It has been shown that $\alpha - 1 = \beta$ and $a = b$. Hence, in the region of the "normal" stationary relationships, the kinetics of the light sum of phosphorescence are identical with the kinetics of photoconduction. F. LACHMAN

535.372

**4862. Kinetics of emission of sulphide phosphors with several activators.** M. SCHÖN. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 333–42 (1948) *In German.*

In crystal phosphors with several activators the

ensity of a given emission band is not ∝ the responding activator but depends on the intensity d wavelength of the exciting light and on the nperature. The fluorescence and afterglow are also ferent. This is explained as follows: the emission lows from the recombination of electrons excited o the conduction band with the ionized activator that the rate of recombination depends on the ensity of excitation and on its spectral distribution. short-wave excitation the deeper lying levels of e activator are relatively more favoured than the gher levels would be in the case of a thermal uilibrium, which is only established slowly by eraction of the activators with the valency band ctrons. The rate of establishment of this equilium runs parallel with that of the recombination ocess and is strongly temperature dependent. eaction equations for phosphors with two activators e set down and solved. The effect of killers is ated to similar causes. The interaction effects of tivator with valency band influences phosorescence, which is weakened or lost if only deepng activator terms are excited. Some quantitative servations are made on the term scheme of ZnS osphors. J. EWLES

535.372

**4863. Width of emission bands in sulphide phosphors.** . SCHÖN. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 343–4 (1948) *German.*

In sulphide phosphors the emission bands, even at mperatures of 12·5°K have a ½-width of some tenths an eV. This cannot be due to temperature distribun of the excited electron in the conduction band id has hitherto been attributed either to the crystal ld or to variation of the centre structure. A further ssibility is here suggested—that it is due to a spread null point vibrational energy of the crystal in the ighbourhood of the activator. J. EWLES

535.372

**4864. On the connection between the probabilities direct and inverse spectral transformation of light in e process of luminescence.** E. I. ADIROVICH. *Dokl. kad. Nauk, SSSR*, **69** (*No.* 6) 759–62 (1949) *In Russian.*

The possibility is demonstrated of applying general rinciples of statistical thermodynamics to the minescence of bodies whose states are not in ermodynamic equilibrium; also a connection is tablished between the probabilities of the direct nd inverse spectral transformation of light. The llowing equations have been obtained

$$\frac{\eta(\nu', \nu)}{\eta(\nu, \nu')} = \left(\frac{\nu}{\nu'}\right)^2 e^{-h(\nu-\nu')/kT}$$

nd

$$\frac{\rho(\nu', \nu)}{\rho(\nu, \nu')} = \frac{A(\nu)}{A(\nu')}\left(\frac{\nu}{\nu'}\right)^2 e^{-h(\nu-\nu')/kT}$$

here $\nu'$ and $\nu$ are frequencies of the absorbed and mitted radiation, respectively, $\eta(\nu', \nu)$ the probability f a quantum $h\nu'$ belonging to the field of radiation eing transformed into a quantum $h\nu$ (the probability eing expressed in energy units), $\rho(\nu', \nu)$ the energy ield of the luminescence of frequency $\nu$ when the minophor was excited by frequency $\nu'$, $A(\nu')$ the probability of a quantum $h\nu'$ being absorbed. At the same time the relationship

$$\rho(\nu', \nu) \leqslant \left(\frac{\nu}{\nu'}\right)^2 \frac{e^{-h(\nu-\nu')/kT}}{A(\nu')}$$

has been found confirming the law of Vavilov regarding the decrease of the energy yield of luminescence in the anti-Stokes region of the spectrum [Vavilov, *Izv. Akad. Nauk, SSSR, Ser. Fiz.*, **7**, 3 (1943); *Journ. of Physics, USSR*, **9**, 68 (1945); **10**, 499 (1946); Jubilee edition, *Akad. Nauk, SSSR*, **1**, 377 (1947)].

F. LACHMAN

535.372

**4865. The absorption and emission of the sublimate phosphor KCl–Tl.** K. V. SHALIMOVA. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 225–8 (1950) *In Russian.*

535.375.5

**4866. Raman spectrum of fluorspar and its temperature variation.** D. C. PRESS. *Proc. Indian Acad. Sci. A*, **31**, 56–9 (*Jan.*, 1950).

Using the λ2536 Hg resonance radiation as exciter, the Raman spectrum has been investigated over the range 313°K to 559°K. The spectrum exhibits a single Raman line with a frequency shift 321·5 $cm^{-1}$ at 313°K which decreases to 312·2 $cm^{-1}$ at 559°K. The width of line increases from 8·7 $cm^{-1}$ to 20·8 $cm^{-1}$ over the same range of temperature. The temperature-frequency shift and the temperature-width curves are similar in nature. A.

535.375.5

**4867. Empirical convergence correction of depolarization measurements.** D. H. RANK AND R. F. KAGARISE. *J. Opt. Soc. Amer.*, **40**, 89–92 (*Feb.*, 1950).

A spiral Hg arc light source of the low-pressure variety and 2 kW power dissipation is described. The use of this powerful but geometrically undesirable arrangement for making depolarization measurements is investigated. Calculations of convergence errors using the polarized incident light method of Edsall and Wilson indicate a linear convergence correction of measured $\rho$-values. Measurement of depolarization values of Raman lines whose $\rho$-value is accurately known confirms the theoretical calculation of convergence correction. From the results moderately accurate $\rho$-values can be obtained by this method by using an empirical correction curve. A.

535.375.5

**4868. Raman spectrum of fluorine.** D. ANDRYCHUK. Letter in *J. Chem. Phys.*, **18**, 233 (*Feb.*, 1950).

535.375.5

**4869. The infra-red and Raman spectra of chlorine monofluoride.** E. A. JONES, T. F. PARKINSON AND T. G. BURKE. Letter in *J. Chem. Phys.*, **18**, 235–6 (*Feb.*, 1950).

535.375.5.072

**4870. Self-recording photo-electric spectrograph for the investigation of optical Raman spectra.** M. M. SUSHCHINSKII. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 221–4 (1950) *In Russian.*

535.376 : 537.542

**4871. Temperature variation of decay times of scintillation phosphors.** S. H. LIEBSON AND J. O. ELLIOT. Letter in *Phys. Rev.*, **78**, 65 (*April* 1, 1950).

535.376 : 539.172.4

**4872. Excitation of phosphors by the energetic fission fragments of uranium.** I. Bröser and H. Kallmann. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 1–2) 85–9 (1948) *In German.*

Scintillations from the excitation of a ZnS–Ag phosphor by $U^{238}$ fast neutron fission fragments (initial energies 60–90 MeV) were detected by a photomultiplier and amplified: the peak pulse amplitudes were about 3× those produced by the U α-particles, and the duration a few μsec. The efficiency of the kinetic energy to light conversion process is ~ 3%, compared with 25% for α-particles.

A. O. STANESBY

535.39

**4873. Calculation of the variation of optical constants of agglomerate layers [couches lacunaires].** D. Malé. *C.R. Acad. Sci., Paris,* **230,** 286–8 (*Jan.* 16, 1950) *In French.*

A graphical method is described for the determination of the optical constants of thin films of non-uniform density. It is based on the fact that the complex refractive index can be represented by a point in the Argand diagram. A qualitative comparison with experimental results is quoted. Two graphs are given.

R. A. WEALE

535.39

**4874. An integrating sphere for reflectance measurements in the ultraviolet.** N. A. Finkelstein. Letter in *J. Opt. Soc. Amer.*, **40,** 178–9 (*March*, 1950).

535.39 : 535.343–15

**4875. On the reflectivity and absorptivity of metals.** E. Vogt. *Ann. Phys., Lpz.* (*Folge* 6) **3,** 82–8 (1948) *In German.*

This discussion of the theory underlying Weiss's i.r. reflectivity on Cu, Fe and manganin at −183°C and +20°C [see Abstr. 3243 (1948)] shows that Cu obeys the Mott–Zener formulae: agreement is obtained by assuming a surface resistivity equal to twice the bulk resistivity. Manganin obeys the Hagen–Rubens relation. Fe behaves like a transition element, the increased absorption being due to transitions from the *d*- to the *s*-shell. Tables and a graph are given.

R. A. WEALE

535.39 : 535.343.2

**4876. Reflectance as a measure of absorption in solid crystalline materials.** P. D. Johnson and F. J. Studer. Letter in *J. Opt. Soc. Amer.*, **40,** 121 (*Feb.*, 1950).

535.39 : 535.41

**4877. Application of quadripole theory to the problems of the reduction of reflectivity, heightening of reflectivity and the interference filter.** K. Schuster. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 6) 352–6 (1949) *In German.*

The quadripole theory long used in conduction problems and h.f. techniques can be applied to the light transmission and reflection properties of a series of plane parallel layers behind each other. For light at normal incidence it is possible to derive equations readily. The reduction of reflectivity through a double layer is treated as a special case. S. TOLANSKY

535.39 : 666

**4878. Low reflection films on glass by an improv chemical method.** F. H. Nicoll. *RCA Rev.*, 3 440–7 (*Dec.*, 1949).

Reports some of the progress made in improvi and extending the earlier H.F. vapour method reducing glass reflection previously reported [Abs 633 (1942)]. A large reduction in the reflection many low-index glasses can be obtained more simp by exposing the glass to the vapour above a solutio of fluosilicic acid at room temp. Characteristics the film and the effect of temp., composition an concentration of the acid are described.

535.

**4879. Analytic and graphical methods for t solution of interference problems when using thin film** H. Pohlack. *Ann. Phys., Lpz.* (*Ser.* 6) **5** (*No.* 6– 311–28 (1950) *In German.*

Reflection formulae for multiple-layers of thin film are derived using matrix methods. A graphic method giving approximate solutions is develope Systems for both increasing the reflectivity of met surfaces and reducing the reflectivity of glass surfac are discussed. Formulae are given in a form suitab for application to practical cases. S. TOLANSK

535.41

**4880. The functioning of the Fabry–Pérot interfer meter; improvement in contrast and luminosity** C. Dufour. *J. Rech. Cent. Nat. Rech. Sci.* (*No.* 1 1–16 (1950) *In French.*

A discussion of the factors affecting contra visibility and intensity in various interferometer particularly the Fabry–Pérot. By the deposition c alternate layers of cryolite and ZnS on the silvere surface, considerable increase in resolving power an contrast is obtained. Measurements are given an applied also to the thin film interferometric filte It is concluded that the performance of an etalon i not so much limited by the properties of the thi film but by the surface imperfections. In the F.P interferometer a practical contrast of 200, permittin the detection of a weak satellite of relative strengt 1/1 000, represents the present limit with a singl interferometer. The theory is applied to combina tions of etalons in series, both with and witho intermediate "focalization." It is considered that th F.P. interferometer presents important advantage over other instruments. Combinations of multipl etalons are discussed and it is suggested that th usual semi-transparent mirrors should be replaced b multiple films. S. TOLANSK

535.417

**4881. Arrangement for observing the rays of equa inclination by reflection.** J. Rabinovitch. *Rev. Opt* (*Théor. Instrum.*) **29,** 135–40 (*March*, 1950) *In French*

A description is given of a simple arrangement fo projecting on a screen ring fringes of equal inclinatio by reflection from a sheet of mica, the arrangemen used enabling the centre of the system to be obtained The effect of finite source dimensions is examine and the degree of monochromaticity required dis cussed. Discontinuous variations in thickness due t cleavage are considered. Only two-beam interference is discussed. S. TOLANSK

535.417 : 531.715.1

**Measuring a large displacement by interferometry.** *See Abstr.* 4730

535.417 : 539.133

**Direct optical measurement of the length of organic molecules.** *See Abstr.* 5186

535.42

**4882. On certain integral equations in diffraction theory.** J. W. MILES. *J. Math. Phys.*, **28**, 223–6 (*Jan.*, 1950).

535.42 : 534.26

**4883. On the theory of diffraction.** W. FRANZ. *Z. Phys.*, **125** (*No.* 7–10) 563–96 (1949) *In German.*

Gives an approximation method for solving the acoustic and optical problem of diffraction. It contains the Kirchhoff diffraction theory as a special case of the first approximation. But both reflection and refraction can be taken into account. The method is also not restricted to short wavelengths. The first and second approximations are computed for the bright semi-plane and the higher approximations for the small bright sphere. H. G. SOLOMON

535.421

**4884. The production of optical gratings by the photographic method.** K. GUNDLACH AND J. RZYMKOWSKI. *Z. wiss. Photogr.*, **45** (*No.* 1–3) 8–31 (1950) *In German.*

A comprehensive historical survey of earlier attempts to produce high resolution optical gratings by photographic methods. Direct photographic reduction of a drawing is not sufficiently accurate. A detailed discussion is given of fine grain characteristics needed for direct copying of a grating, a modified Fox Talbot early photographic technique which did not employ Ag salts is found to be suitable for grating copies. Modern Kollargol techniques are described. A comprehensive literature is included. S. TOLANSKY

535.43

**4885. Scattered light measurement with an integrating sphere.** W. BECKER. *Optik*, **6**, 105–10 (*Feb.*, 1950) *In German.*

The measurement of scattered light with an integrating sphere is shown to depend upon the scattering characteristics of the surfaces under test. While this affects the absolute values of scattering coefficients obtained, this variation does not lower the value of the method for the comparison of contrast reduction in instruments of a similar type. Geometric conditions are derived for the uniform illumination of the photometer field and the absence of disturbing effects due to diffraction at the lens mounts. The contrast reduction in a telescopic system is calculated in terms of the target brightness and the measured scattering coefficient. R. W. FISH

535.515

**4886. Dispersion of the birefringence in barium titanate.** L. E. CROSS, M. M. NICOLSON, B. ZLOTNICKI AND R. WHIDDINGTON. Letter in *Nature, Lond.*, **165**, 440–1 (*March* 18, 1950).

Details are given of measurements with a grating spectrometer on a flat plate type of crystal containing a single twin boundary running parallel to the plate edge and at 45° to the larger surface. The range covered is 4 000–7 000 Å and the shape of the birefringence-wavelength curve indicates an absorption frequency at about 3 800 Å. H. G. JERRARD

535.543

**4887. Channeled infra-red spectra produced by birefringent crystals.** J. W. ELLIS AND L. GLATT. *J. Opt. Soc. Amer.*, **40**, 141–2 (*March*, 1950).

An i.r. absorption spectrum produced by a section of a birefringent crystal often has superimposed upon it a channelled spectrum when the beam is plane or partially polarized. This channelling is absent when the electric vector $E_i$ of the incident polarized beam parallels one of the principal index axes of the crystal, and usually appears with greatest visibility when $E_i$ makes a $\pm 45°$ angle with such an axis. However, even in the latter instance, it does not occur provided the index axes in the crystal surface are parallel and perpendicular, respectively, to the plane of incidence of the dispersing prisms, unless there is some uncompensated optical rotation in the spectrograph system. The maxima and minima of the channelled spectrum are caused by a combination of a wave plate interference action within the crystal section and an analyser action involving reflection losses at the prism faces. Optical rotation in the system also usually causes the visibility contrast between maxima and minima to vary, with one or more zero visibility positions resulting. A.

535.565

**4888. The total reflection of natural light at a non-absorbing inactive [uniaxial] crystal.** F. SCHWIETRING. *Optik*, **6** (*No.* 1) 20–39 (1950) *In German.*

The crystal is considered to be immersed in an optically denser medium and equations are developed for the properties of the reflected ray as the angle of incidence ($i$) increases to pass through the two critical angles ($\phi_1$, $\phi_2$) in turn; the development uses the fact that there exist "uniradial" polarization azimuths such that a plane polarized ray is refracted as a single ray. It is shown that with unpolarized incident light, the reflected light is partially plane polarized for $i < \phi_1$ and $\phi_1 < i < \phi_2$; for $i > \phi_2$ the reflected light remains unpolarized. The results are important for an understanding of the critical angle method of finding refractive indices of a crystal. G. F. LOTHIAN

535.64

**4889. Maximum attainable luminous efficiency of various chromaticities.** D. L. MACADAM. Letter in *J. Opt. Soc. Amer.*, **40**, 120 (*Feb.*, 1950).

535.65

**4890. Principles of colorimetry.** D. J. LOVELL. *Amer. J. Phys.*, **18**, 104–9 (*Feb.*, 1950).

535.65

**4891. Reducing stray light errors in the Hunter multipurpose reflectometer.** D. J. TROY, JR. AND L. G. GLASSER. *J. Opt. Soc. Amer.*, **40**, 80–2 (*Feb.*, 1950).

535.65

**4892. Abridged spectrophotometric colorimetry with photo-cells.** J. W. PERRY. Letter in *J. Opt. Soc. Amer.*, **40**, 119 (*Feb.*, 1950).

535.65 : 518.5

**4893. Method of colorimetric integration using punched-card accounting machines.** D. L. MacAdam. *J. Opt. Soc. Amer.*, **40**, 138–40 (*March*, 1950).

When colorimetric specifications of a large number of samples need be computed from spectrophotometric data, an important saving of time can be realized by use of standard IBM punched-card computing equipment. The method employs weighted ordinates, and results for two light sources can be obtained with very little more expenditure of time than for one. The method is described, with detailed instructions for the machine operators. A.

535.653

**4894. Munsell renotations used to study color space of Hunter and Adams.** D. Nickerson. *J. Opt. Soc. Amer.*, **40**, 85–8 (*Feb.*, 1950).

535.8

**4895. The quality of optical systems.** F. Blottiau. *Rev. Opt. (Théor. Instrum.)* **29**, 71–8 (*Feb.*, 1950) *In French.*

Developing the ideas of Hartman, Yvon [Abstr. 976 (1926)] and Demetrescu [Abstr. 1431 (1924), 2812 (1926)], the author seeks a single parameter to express the quality of any optical system. Between a point source and the optical system is a diaphragm with a lattice of holes. Photographs are taken in planes before and behind the image plane. The "moment of inertia" of the light patch is determined and related to the value it would have in a perfect system. An expression ($q$) for quality is deduced as a function of these quantities; $q$ is multiplied by the transmission ($t$) of the system. The process is repeated for point sources distributed through the normal object space, and a mean value $q \times t$ obtained. The process may be again repeated for various wavelengths and another mean obtained. G. F. LOTHIAN

535.81 : 539.32 : 534.321.9

**Measurement of elastic constants of optical glass from diffraction patterns of glass cubes vibrating at high frequencies.** *See Abstr.* 5343

535.822.9

**4896. A color translating ultraviolet microscope.** E. H. Land, E. R. Blout, D. S. Grey, M. S. Flower *et al. Science*, **109**, 371–3 (*April* 15, 1949).

535.824

**4897. The measurement of unresolved, single particles of uniform thickness by means of variable phase microscopy.** H. Osterberg and G. E. Pride. *J. Opt. Soc. Amer.*, **40**, 64–73 (*Feb.*, 1950).

The adjustments of a variable phase microscope control two variable experimental parameters, specifically the phase difference $\delta$ between and the amplitude transmission ratio $h$ of the conjugate and complementary areas of the diffraction plate or its polanret equivalent. It is shown that the centre of the sharply focused diffraction image of a single unresolved particle can be brought to zero intensity by a definite choice of the parameters $h$ and $\delta$. The relations which exist among the required choice of $h$, $\delta$, the area and the optical properties of the particle are derived and specialized to various classes of particles. These relations permit the computation of the area and one or more optical properties of the particle from the observed values of the parameters $h$, $\delta$. Observations made upon opaque particles with a modified polanret microscope are described and found to be in accord with the theory. The radii of these particles ranged from 0·5 to 0·15 times the Airy limit of the test objective. A.

535.822

**4898. Colour-contrast phase microscopy.** C. Rimington and I. W. Rowlands. Letter in *Nature Lond.*, **165**, 368–9 (*March* 4, 1950).

535.822

**4899. A phase-contrast unit for a microscope.** M. Françon. *Rev. Opt. (Théor. Instrum.)* **29** 129–34 (*March*, 1950) *In French.*

The phase contrast unit is placed between the specimen under examination and the objective of an otherwise unmodified microscope. A silvered glass hemisphere is cut in two, the plane of section is half silvered, and a phase plate inserted before the two halves are recemented. After reflection at both silvered surfaces, an image of the specimen is formed at unit magnification and with full phase contrast. This image is shown to be free from aberration and of wide enough angle to be used with dry or immersion objectives of up to 1·30 N.A. R. W. Fish

535.83

**4900. The effective power of binocular terrestrial telescopes.** M. Berek. *Z. Phys.*, **125** (*No.* 7–10) 657–78 (1949) *In German.*

The investigation relates to the visual thresholds which result from the physiological laws in the use of binocular terrestrial telescopes, to the observations with which a general law of perception formulated by the author [Abstr. 3046 (1948)] is adapted. As long as the exit-pupil of the telescope is $<$ the pupil of the eye, the criterion of the visual thresholds as well as of the effective power of the telescope in contrast to the naked eye is the product of the magnification of the telescope and its exit-pupil, but is the magnification only when the exit-pupil exceeds the pupil of the eye. The theoretically highest effective power is numerically equal to the value of the magnification of the telescope. Owing, however, to the loss of light in the telescope it is never fully realized. H. G. Solomon

## HEAT 536

536.08

**4901. A temperature-controlled resistance furnace for high temperature measurements.** W. G. Schneider and N. R. S. Hollies. *Rev. Sci. Instrum.*, **21**, 94–5 (*Jan.*, 1950).

536.2

**4902. On the equilibrium distribution of the temperature of a ring kept in surroundings at different constant temperatures.** C. Casci. *Atti Accad. Naz. Lincei (R.C. Cl. Sci. Fis. Mat. Nat.)*, **7**, 219–24 (*Nov.*, 1949) *In Italian.*

536.21

**4903. Measurement of the thermal diffusivity of a soil by the use of a heat pump.** E. B. Penrod. *J. Appl. Phys.*, **21**, 425–7 (*May*, 1950).

536.212.2 : 538.69

**4904. The thermal conductivity of metals in a strong magnetic field.** M. KOHLER. *Ann. Phys., Lpz.* (*Folge 5*) **5** (*No.* 3–5) 181–9 (1949) *In German.*

A theory is given of the relation between the electrical conductivity of metals and the electronic contribution to the thermal conductivity in the limiting case of high magnetic fields. The linear relation of Grüneisen and de Haas is shown to be invalid for divalent metals or for any two-band model in which the number of electrons in one band is precisely equal to the number of holes in the other. A simple relation between the Hall and Righi–Leduc coefficients is deduced. A new method of determining the electronic and lattice contributions to the thermal conductivity from experimental measurements gives results for $Be_2$ crystals in agreement with those obtained by the Grüneisen–de Haas method.

R. B. DINGLE

536.23 : 533.73

**4905. The thermal accommodation coefficients of gases. I. An investigation of the effect of flashing.** G. M. BREMNER. *Proc. Roy. Soc. A*, **201**, 305–20 (*April* 26, 1950).

The fall in heat loss after flashing has been confirmed, but it is accounted for, not by a reduction in the accommodation coefficient, but by the persistence of the thermal effects of flashing. Thus the effect of flashing is accentuated by working with silvered and platinized vessels; it is reproduced by flashing an adjacent wire and is particularly evident when working *in vacuo*. Abnormal temperature rises can also be observed when pipette methods are used to introduce the gas to an evacuated vessel. The results obtained in similar experiments were shown to be due mainly to the slowness of the diffusion process.

A.

536.23 : 533.73

**4906. The thermal accommodation coefficients of gases. II. Determinations at room and at liquid-oxygen temperatures.** J. G. M. BREMNER. *Proc. Roy. Soc. A*, **201**, 321–9 (*April* 26, 1950).

The accommodation coefficients of He, N, A, H and O, on a W surface, are smaller at liquid-oxygen than at room temperature. The accommodation coefficients of the inert gases varies, at both temperatures, approximately as the square root of the atomic weights. The increase in the accommodation coefficient of He, with the hot-working of the wire observed by Roberts [*Proc. Roy. Soc. A*, **129**, 146 (1930)] has not been confirmed for heating times up to 30 hr.

A.

536.23 : 536.633 : 533.16

**4907. A method for the determination of the specific heat, the viscosity and the heat conductivity of gases.** H. SENFTLEBEN AND H. GLADISCH. *Z. Phys.*, **125** (*No.* 7–10) 653–6 (1949) *In German.*

The method is based on a previous investigation and the same apparatus is used [Abstr. 4911 (1950)]. Values are tabulated for: $C_2H_6$; $C_2H_4$; $C_2H_2$; $C_3H_6$; $C_4H_{10}$; $C_4H_8\alpha$; $C_4H_8\beta$; $C_4H_6$; $C_4H_4$; $CH_3Br$; $CH_3Cl$; $CH_2Cl_2$; $C_2H_5Cl$; $(C_2H_5)_2O$.

H. G. SOLOMON

536.24

**4908. On the application of graphical methods to the problems of heat conduction. (A study on the graphical integration of the partial differential equations of diffusion type.)** I. OSIDA. *J. Phys. Soc. Japan*, **3**, 223–34 (*July–Aug.*, 1948).

536.24 : 536.48

**4909. Thermal exchange coefficients in boiling nitrogen.** L. WEIL AND A. LACAZE. *C.R. Acad. Sci., Paris*, **230**, 186–8 (*Jan.* 9, 1950) *In French.*

For use in a H liquefier, values of $P$, the heat exchanged per sec per unit surface area between heated Cu wires or tubes and liquid N boiling under atm. pressure as a function of $\Delta t$ the temp. difference between the surface and liquid, and of $\alpha = P/\Delta t$, have been measured. $\Delta t$ was obtained from the electrical resistance of the immersed Cu, being calibrated at fixed points. For $P$ two methods were used, an electrical one in which the current through the heater and the p.d. between two points near the ends were measured, and a volumetric one in which the amount of N vaporized was measured. The former does not apply above $\Delta t \simeq 10°C$ where $P$ is max. Results are shown graphically for a plate, 49·5 cm², consisting of a spirally wound tube of $\sim$ 1 mm dia. and $\sim$ 1 m long. $P_{max}$ was 8·5 $Wcm^{-2}$.

S. WEINTROUB

536.242

**4910. Heat transfer to fluids flowing through a bed of granular solids.** H. VERSCHOOR AND G. C. A. SCHUIT. *Appl. Sci. Res.*, **A2** (*No.* 2) 97–119 (1950).

Heat transfer data between fluid and wall have been collected for fluids flowing through tubes containing a granular material. A relation is presented between the effective coefficient of heat conductivity, the flow condition of the fluid, the particle size and the tube size.

A.

536.244

**4911. Heat transfer in gases between coaxial cylinders.** H. SENFTLEBEN AND H. GLADISCH. *Z. Phys.*, **125** (*No.* 7–10) 629–52 (1949) *In German.*

In investigating the effect of electric fields on the heat transfer in gases [Abstr. 208 (1949)] it was found necessary to examine the heat transport conditions between coaxial cylinders (radii: $R$ and $r$). For $R \gg r$ and small values of the Grashof number the Nusselt heat transfer functions and the position of the centre of gravity and the temperature of the flow are obtained for the case of free flow. The tests were carried out with a thin Pt wire in the axis of a glass tube filled with the gas under investigation. The wire is connected in a Wheatstone bridge, the current for the measurement serving as the heating current. The apparatus is schematically illustrated. [See also Abstr. 921, 4907 (1950)].

H. G. SOLOMON

536.413.2

**4912. The measurement of the thermal expansion of single crystals of tin by an interferometric method.** B. G. CHILDS AND S. WEINTROUB. *Proc. Phys. Soc., Lond. B*, **63**, 267–78 (*April*, 1950).

Single crystals of Sn have been grown by the Kapitza method, their orientations measured, and the crystals converted into sets of 3 spacers for use

in an interferometric dilatometer. The dilatometer consisted of a vacuum furnace for heating the spacers and interferometer, and an auto-collimating monochromator. The movement of the fringes with change of temperature was observed visually. The apparatus, its assembly, and method of use are described in detail. The linear expansion coefficients, $\alpha_\theta$, of 6 crystals of different orientations, $\theta$, have been measured over the range of temperature 30–220°C., and $\alpha_\theta$ for a given temperature was $\propto \cos^2\theta$ in accordance with Voigt's relation. The two principal coefficients, $\alpha_{||}$ and $\alpha_\perp$, corresponding to $\theta = 0$ and $\theta = 90°$ were found by extrapolation. $\alpha_{||}$ and $\alpha_\perp$ increase with temperature from $32{\cdot}0$ and $16{\cdot}2 \times 10^{-6}$/deg. C at 30°C to $41{\cdot}5$ and $20{\cdot}3 \times 10^{-6}$/deg C at 230°C respectively. The accuracy of the determination is estimated to be within 1%. The results are exhibited in graphical and tabular form. A.

536.413.2

**4913. The effect of compressive stresses on the linear thermal expansion of magnesium and steel.** J. L. Rosenholtz and D. T. Smith. *J. Appl. Phys.*, **21**, 396–9 (*May*, 1950).

A series of cylinders of annealed, extruded, pure Mg and medium soft steel were subjected to a sequence of compressive stresses at room temperature and their respective coefficients of linear thermal expansion in the direction of stress application were determined for the range 20° to 100°C. The cylinders were then heat treated to permit either recovery or recrystallization and the changes in length were measured. Characteristic curves are given for each metal in which the coefficient of linear thermal expansion and length changes are plotted as a function of the true compressive stress. It is shown that these properties may be used to determine the stress history of a test specimen for which characteristic curves are available. It is suggested that this stress analysis technique may find application in the study of rock deformation and in the investigation of metals, both before and after failure. A.

536.413.2 : 548.55

**The preparation of metal single crystals for expansion measurements.** *See Abstr.* 5394

536.421.1

**4914. A note on the theory of melting.** J. K. Mackenzie and N. F. Mott. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 411–12 (*April*, 1950).

536.422.5

**4915. The deposition of ice crystals on cooling surfaces in low temperature plant.** G. G. Haselden. *Proc. Phys. Soc., Lond. A*, **63**, 157–66 (*March* 1, 1950).

A study is made of the conditions governing the deposition of ice crystals from a moist air stream on to the inside surface of a cooled tube. The promoting effect of impurities such as oil vapour in the air stream is demonstrated. Series of experiments were made to establish the effect of air velocity, and of the temperature difference between the tube wall and air stream, on the amount of deposition. In the flow range tested (Reynolds number 11 000 to 27 000) it was observed that increasing the air velocity increased the percentage deposition; at the lower velocities there was no evidence of progressive deposition. The effect of temperature difference on the percentage adhesion i the range 7° to 14°C was small, but an experiment at value of 4·6°C showed a decrease in the amount condensed snow deposited. In most experiments glass tube was used but in others use of a brass tub gave similar results.

536.423.1

**4916. Azobenzene. I. Vapour pressure of *cis* and *trans*-azobenzene.** N. F. H. Bright, T. Carso and T. A. Dyson. *Research, Lond.*, **3**, 185– (*April*, 1950).

This has been measured by an effusion techniqu over the temperature range 30 to 62°C. The result for the two isomers can be represented by th equations $\log_{10} p = -(3\,911/T) + 9{\cdot}721$ for th *trans* isomer and $\log_{10} p = -(3\,914/T) + 9{\cdot}652$ fo the *cis* isomer, where $p$ is in mm of mercury and $T$ is the absolute temperature. Both isomers can b vaporized within this temperature range and re condensed without observable interconversion. A.

536.42

**4917. Calorimetric investigations of transitions in $NaNO_3$ and $KNO_3$.** Heikki Miekk-Oja. *Ann. Acad. Sci. Fennicae, Ser. A*1 (*No.* 7) 3–65 (1941) *In German*

An adiabatic electrically heated calorimeter of the Moser type [*Phys. Zeits.*, **37**, 737 (1936)] was used to measure the heat capacity of Ni, $NaNO_3$ and $KNO_3$ with an accuracy $\sim 1\%$. The same apparatus was also used in cooling experiments on the salts. The well-known $C_p$-$T$ curve of Ni was reproduced, agreement within $\pm 2\%$ with several previous investigations being obtained. $NaNO_3$ showed a sharp peak at $276{\cdot}5 \pm 1{\cdot}0$°C, with an integrated heat of transformation of $10{\cdot}6$ cal./g. In the adiabatic heating experiments $KNO_3$ showed a rise in $C_p$, too steep to be followed, setting in at $129{\cdot}5 \pm 0{\cdot}2$°C. The normal course of the curve was resumed at $\sim 180$°, the integrated heat of transformation being $\sim 12{\cdot}8$ cal./g. In the cooling experiments $KNO_3$ showed only a slight rise in the range 180°–129°, but at $123{\cdot}2 \pm 0{\cdot}2$° there was a rapid rise, and $C_p$ remained high (variation complex, and dependent on the rate of cooling) to $\sim 105$°. The integrated heat of transformation was, however, very similar, $\sim 13{\cdot}1$ cal./g. The nature of the transformation is discussed; it is probably the onset of a hindered rotation. A. J. C. Wilson

536.424

**4918. On the phase transition of barium titanate. II.** R. Ueda. *J. Phys. Soc. Japan*, 333–8 (*Sept.–Dec.*, 1948).

536.424 : 548.736.3

**4919. X-ray and thermal studies on the phase transitions of cuprous sulphide $Cu_2S$.** R. Ueda. *J. Phys. Soc. Japan*, **4**, 287–92 (*July–Dec.*, 1949).

536.46

**4920. On the theory of the velocity of combustion, with an application to the combustion of ozone.** K. Bechert. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 5) 191–230 (1949) *In German.*

Identical with Abstr. 2405 (1950). A. Schofield

536.46

**121. On the theory of combustion velocity. II. action between dissimilar particles—the combustion hydrocarbons.** K. BECHERT. *Ann. Phys., Lpz.* olge 6) **5** (*No.* 6–8) 349–72 (1950) *In German.*

Theoretical. The treatment is analogous with that a previous paper [Abstr. 2405 (1950)]. It is assumed at the end-products of reaction are $CO_2$ and $H_2O$ th free hydrocarbon if the mixture is fuel-rich. lculation of the flame velocity shows that it attains maximum when the mixture is fuel-rich; for hexane d pentane the calculated maximum velocity agrees ll with experiment, but the corresponding mixture mposition is widely in error. Defining the compn. a parameter $\varepsilon = \sigma/\sigma_s$ where $\sigma$ is the ratio of the rtial pressure of the fuel to the total pressure in the burnt mixture, and $\sigma_s$ is the value of $\sigma$ for the ichiometric mixture, the maximum velocity is lculated to occur at $\varepsilon = 4$ whereas the experimental aximum is at $\varepsilon = 1{\cdot}1$. Limits of inflammability e examined. For a wide range of hydrocarbons $= 0{\cdot}55$ at the lower limit, and $1 - \varepsilon\sigma_s/1 - \sigma_s =$ 94 at the upper limit. The temperature of the oducts of combustion is also approximately constant 1 500°C for the lower limit and 2 300–2 400°C for e upper limit. A. SCHOFIELD

536.46

**122. Combustion of liquid fuel in a gas stream. II.** B. SPALDING. *Fuel*, **29**, 25–32 (*Feb.*, 1950).

See Abstr. 2412 (1950). Experiments are described which kerosene is burned by natural convection om the surface of a vertical plate and a sphere in r of various O contents. The combustion rates are und to accord broadly with those predicted eoretically and some light is thrown on the combustion mechanism and the causes of smoke formaon. A.

536.46

**123. The propagation of flames in tubes.** P. J. HEATLEY. *Fuel*, **29**, 80–3 (*April*, 1950).

An attempt has been made to apply the Coward nd Hartwell method of determining burning elocities to faster burning mixtures than hitherto mployed. It is found that the method is not satisctory. Other workers have shown that certain ixtures can have two uniform flame speeds, or that e speed may change from one uniform value to nother. Photographs obtained during the present vestigation show that this is due to the flame front, hilst still remaining smooth, changing from an pright to a slanting form. Furthermore, the photoraphs show that the uniform motion may be compounded from these two speeds in any proportion, nd hence suggest that the electrical methods of etermining flame speeds yield results which are not ecessarily reliable. A.

536.48

**924. Discussion of the properties of helium II on the asis of the two fluid model.** C. J GORTER, P. W. ASTELEIJN AND J. H. MELLINK. *Physica*, **15**, 113–21 *eb.*, 1950).

Smoothed values of the specific heat and of the ntropy of liquid He II are given. It is pointed out hat systematic differences occur between fountain effects, second sound velocities, mechano-caloric effects and heat currents and those expected from Tisza's special two-fluid model. The more general model proposed by one of the authors enables one to reach a better agreement although the special model still remains a valuable first approximation. In an appendix formulae are proposed for the velocities and for the absorption of second sound. A.

536.48

**4925. Properties of superflow in liquid helium II.** R. BOWERS AND K. MENDELSSOHN. *Proc. Phys. Soc., Lond. A*, **63**, 178–80 (*Feb.*, 1950).

Experiments are described which show that below a certain critical velocity of flow there is no appreciable gradient of either pressure or temperature in a narrow slit connecting two volumes of liquid He II. Beyond a certain saturation rate, increased heat input into one of the volumes does not result in a higher rate of flow through the slit. There is also a kink in the curve giving the rate of flow at a lower value (corresponding to a rate $\simeq$ to that of the flow under gravity), which is associated with an apparent decrease in pressure near the middle of the slit.

R. B. DINGLE

536.48

**4926. Transfer rates for surface films of He II.** E. J. BURGE AND L. C. JACKSON. Letter in *Phil. Mag.*, **41**, 205–7 (*Feb.*, 1950).

Experiments are described which show that the creep rate of He II films over clean surfaces is independent of the geometry of the system and is of the magnitude observed by Daunt and Mendelssohn in 1939. If the surfaces are contaminated, the rate may be increased by a factor as large as 7, and becomes dependent on the height of the rim of the vessel above the highest He level. For both clean and contaminated surfaces the rate is independent of the difference of the two levels. R. B. DINGLE

536.5.081

**4927. The International Temperature Scale—1948 revision.** J. A. HALL AND C. R. BARBER. *Brit. J. Appl. Phys.*, **1**, 81–6 (*April*, 1950).

Gives the essential details of the new scale and discusses the changes which have been made and the reasons underlying them. The most important differences are: (1) the use of a value of 960·8° instead of 960·5°C for the freezing point of Ag; (2) the adoption of the Planck equation instead of that of Wien for extrapolation to high temperatures; (3) the use of a value of 1·438 instead of 1·432 for the constant of $C_2$ in the Planck equation; (4) the use of the name "Celsius" instead of "Centigrade." The effect of these changes on the numerical values of temperature is given in graphical form. The reproducibility of the scale is discussed and an estimate is made of the accuracy with which it represents the thermodynamic scale. A.

536.532

**4928. A simplified method for the calibration of thermoelements.** G. MEYER AND J. W. FRANKEN. *Rec. Trav. Chim. Pays-Bas*, **69**, 515–19 (*March*, 1950).

The potentiometric method is modified by using a Pt/Pt 10% Rh thermocouple, with hot junction at the steam point, in place of the usual battery.

S. WEINTROUB

536.55 : 533.6.08

**4929. Vortex thermometer for measuring true air temperatures and true air speeds in flight.** B. VONNEGUT. *Rev. Sci. Instrum.*, **21**, 136–41 (*Feb.*, 1950).

The aerodynamic heating experienced by thermometers exposed from aeroplanes can be very nearly eliminated over a wide range of operating conditions by mounting the thermometer in the centre of an air vortex created by a simple housing. This method has been found to simplify air temperature measurements up to 250 m.p.h. The instrument has promise for measuring temperatures in clouds. True air speeds can be measured by the difference between the temperature of the vortex thermometer and a thermometer exposed in the usual manner. Designs and flight data are presented for several vortex thermometers and a simple true air speed indicator. A.

536.581.1

**4930. A proportional reset furnace controller for temperatures up to 1 600°C.** R. W. NURSE AND J. H. WELCH. *J. Sci. Instrum.*, **27**, 97–9 (*April*, 1950).

A controller is described which will regulate the temperature of an electric furnace within ± ½°C up to 1 600°C. The control element is a resistance thermometer which may, if desired, be the heating element. Provided the resistance of this control element is unaffected by long periods at high temperature, the system is free from drift. The electronic unit, which is substantially unaffected by supply frequency and voltage variations, is described in detail. A.

536.63

**4931. On the specific heat of the natural rubber.** H. ICHIMURA. *J. Phys. Soc. Japan*, **3**, 305–7 (*Sept.–Dec.*, 1948).

536.63 : 536.65 : 539.155.2

**4932. Difference between the thermal-caloric properties of heavy and light water.** A. EUCKEN. *Nachr. Wiss. Göttingen* (*No.* 1) 1–11 (1949) *In German.*

Observation shows that the thermal-caloric properties of isotopic molecules are usually different although the electron structure is the same. A large part of this difference can be attributed to the mass difference of the isotopes. This leads immediately to different eigen frequencies and the thermal properties which depend on these will differ. In the first case the zero point energy is affected and an example of this is the difference of the heat of sublimation of ice which is examined numerically. The difference of the molecular heats of light and heavy water is discussed in terms of the formation of molecular aggregates, the anharmonicity of translational and torsional movements and the contribution from intramolecular vibrations. Finally the difference of the molecular volumes and the variation of this with pressure and temperature is examined and explained in a similar manner. F. E. HOARE

536.653

**4933. The heat of formation of KCl–KBr mixed crystals precipitated from aqueous solution.** N. FONTELL, V. HOVI AND A. MIKKOLA. *Ann. Acad. Sci. Fennicae, Ser. A*1, *Paper* 54, 4 *pp.* (1949).

536.653

**4934. The heat of formation of KCl–RbCl solid solutions.** N. FONTELL, V. HOVI AND L. HYVÖNEN. *Ann. Acad. Sci. Fennicae, Ser. A*1, *Paper* 65, 7 *pp.* (1949).

536.6

**4935. Calculation of heats of adsorption fr adsorption isosteres.** R. S. HANSEN. *J. Phys. Co Chem.*, **54**, 411–15 (*March*, 1950).

536.6

**4936. Heats of adsorption. III. Methanol carbon.** C. PIERCE AND R. N. SMITH. *J. Phys. Co Chem.*, **54**, 354–64 (*March*, 1950).

536.

**4937. The heat of formation of KCl–KBr sol solutions.** V. HOVI. *Ann. Acad. Sci. Fennicae, Se A*1, *Paper* 55, 55 *pp.* (1948).

A slightly modified form of Fontell differenti calorimeter is used to measure the heats of formati of several KCl–KBr mixed crystals. The crysta were prepared in various ways from the melt. TI effects of heat treatment and crystal composition c the ageing rate of annealed specimens, as deduce from the heats of formation obtained, are discusse The experimental apparatus, its performance, th theory of the Fontell method, and the accuracy measurement, are described in detail. The accurac was determined by differential measurements on KC Lange and Monheim's [*Z. Physik. Chem. A*, **15** 349 (1930)] values for the heat of solution of KC being used. Heat differences of < 10 cal. with a accuracy of 1% were measured. The results ar shown in tabular and graphical form. The heat c formation was found to be a highly sensitive indicat of changes. S. WEINTROU

## THERMODYNAMICS 536.7/.8

536.

**4938. The mathematics of elementary thermo dynamics.** K. MENGER. *Amer. J. Phys.*, **18**, 89–10 (*Feb.*, 1950).

536.7

**4939. Solid helium at "high" temperatures.** F. A HOLLAND, J. A. W. HUGGILL, G. O. JONES AND F. E SIMON. Letter in *Nature, Lond.*, **165**, 147–8 (*Jan.* 28 1950).

There is a general empirical formula representing the melting curves of many substances in reduced units, for which one appropriate reduction factor i the internal pressure derived from Van der Waals equation. Since substances with low boiling point have low internal pressures, it is therefore possible to follow their melting curves over a considerable range Experiments on the melting curve of He are described in which the highest pressures are generated by "thermal compression," and solidification detected by the "blocked capillary" method. Hysteresis and non-linearity in the manometers are eliminated by comparing simultaneous observations of the melting pressure of Hg with Bridgman's values. A single relation represents the experimental results up to temperatures as high as 10 times the liquid-gas critical temperature. R. B. DINGLE

536.71

**40. Some calculated properties of tritium.** E. F. AMMEL. Letter in *J. Chem. Phys.*, **18**, 228–9 (*Feb.*, 50).

The modified law of corresponding states obtained the application of quantum theory to the con-ensed permanent gases by J. De Boer [Abstr. 2460 948)] is used to predict various thermodynamic roperties of T. In this way the vapour pressure urve, critical and triple point constants as well as me molecular constants are obtained. For T an terpolation is required whereas the prediction of the roperties of $He^3$ by De Boer and Lunbeck involved graphical extrapolation. F. E. HOARE

536.75 : 530.145.6

**Quantum mechanics and the second law of thermo-ynamics.** *See Abstr.* 4720

## ELECTRICITY 537

537 : 538

**941. The teaching of electricity and magnetism at ie college level. I. Logical standards and critical sues.** E. C. KEMBLE (Chairman) *et al. Amer. J. hys.*, **18**, 1–25 (*Jan.*); *errata*, 88 (*Feb.*, 1950).

Report of the Coulomb's Law Committee of the mer. Assoc. Phys. Teachers, covering: improper se of Coulomb's Law; polarization as a basic oncept; electric and magnetic vectors; Amperian urrents *v.* magnetic poles; acceptable schemes for eaching the fundamental principles.

537 : 538

**942. The teaching of electricity and magnetism at ie college level. II. Two outlines for teachers.** *mer. J. Phys.*, **18**, 69–88 (*Feb.*, 1950).

537.08

**943. There are no e.s.u. and e.m.u. systems of nits; there are systems of dimensionally formless nits, the units being related to one another by imensionless coefficients, and any system can be nade at will either electrostatic or electromagnetic.** R. ESNAULT-PELTERIE. *C.R. Acad. Sci., Paris*, **230**, 37–41 (*Jan.* 23, 1950) *In French.*

It is maintained that the dimensions of electric and electromagnetic quantities cannot be reduced to impler dimensions without losing their physical ignificance. By a suitable choice of dimensionless constants, "e.s.u." and "e.m.u." may be interchanged vithout any particular specification of physical limensions. R. A. NEWING

537.08 : 621.317.725.018.75

**944. A single pulse voltmeter.** G. T. RADO, M. H. JOHNSON AND M. MALOOF. *Rev. Sci. Instrum.*, **20**, 927–9 (*Dec.*, 1949).

The voltmeter described is capable of measuring he average amplitude of a single pulse with a random error of 0·2% of full-scale deflection. It consists of a gated cathode follower bridge in conjunction with a ballistic indicator. In its present form the circuit esponds to the average pulse amplitude over an arbitrarily selected interval of 2 msec; thus, it measures he actual amplitude in the special case of a flat pulse of sufficient duration. The required input is 0·8 V for full-scale deflection. The non-linearity is $< 1\%$ of any given deflection throughout the major part of the range. A.

## THEORY . ELECTRONS 537.1

537.122 : 530.145

**On elementary point-charges. A contribution to classical electron theory.** *See Abstr.* 4707

537.133

**4945. Why does the proton possess a positive charge?** G. PETIAU. *C.R. Acad. Sci., Paris*, **224**, 330–3 (*Feb.* 3, 1947) *In French.*

The connection between the positive charge of a proton, and the negative charge of an electron in a state of positive energy, is studied by considering the interaction, in a photon field, between the electron and a particle whose nature is not specified initially. The latter particle may be a proton with positive charge in three cases; these are characterized. An example studied is that of a particle whose total maximum spin is $(3/2)(h/2\pi)$. L. S. GODDARD

537.133

**4946. The internal diamagnetic field correction in measurements of the proton magnetic moment.** N. F. RAMSEY. Letter in *Phys. Rev.*, **77**, 567 (*Feb.* 15, 1950).

## ELECTROSTATICS . DIELECTRICS 537.2

537.221

**4947. A confirmation of the Workman–Reynolds effect.** V. J. SCHAEFER. Letter in *Phys. Rev.*, **77**, 721 (*March* 1, 1950).

The electrical potential acquired by dilute solutions of salts in the process of freezing was studied in an apparatus similar to that used by Workman and Reynolds [Abstr. 4316 (1949)] and their results were confirmed. In Atlantic sea water, for instance, the potential varied with concentration, reaching a maximum of $+16{\cdot}5$ V at $5\times10^{-4}$ molar. The meteorological importance of the effect is stressed. E. M. FOURNIER D'ALBE

537.226 : 548.7

**Ionic polarisation in crystals: additivity in double salts.** *See Abstr.* 5419

537.226 : 621.317.761.029.64

**4948. A recording microwave refractometer.** G. BIRNBAUM. *Rev. Sci. Instrum.*, **21**, 169–76 (*Feb.*, 1950).

An instrument designed to measure and record a small difference in frequency between two cavity resonators is described. A sweep frequency technique is used to generate the resonance responses of the cavities. These responses are sharpened and made to control the operating time of a trigger circuit, whose average output is metered. A sensitivity of 200 c/s is obtained in the measurement of the frequency difference between two high-$Q$ cavities, with resonance

frequencies of 9 000 Mc/s. Applications of this instrument are discussed, especially those relating to measuring changes in permittivity. A simple extension is suggested for simultaneously recording changes in permittivity and loss. A.

537.226.1

**4949. Dielectric behaviour of methyl palmitate in the microwave region.** H. F. Cook and T. J. Buchanan. Letter in *Nature, Lond.*, **165**, 358–9 (*March* 4, 1950).

537.226.2

**4950. On the effect of mechanical stress upon the permittivity of barium titanate.** Y. Takagi, E. Sawaguchi and T. Akioka. *J. Phys. Soc. Japan*, **3**, 270–1 (*July–Aug.*, 1948).

537.226.2

**4951. Dielectric constant and molecular structure. III. Dielectric constants of amino acids and other dipolar ions.** S. K. Kulkarni Jatkar and B. R. Yathiraja Iyengar. *J. Indian Inst. Sci. A*, **31** (*No.* 3) 15–42 (1950).

537.226.2

**4952. New ferroelectric salts.** G. A. Smolenskiĭ. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 3) 405–8 (1950) *In Russian.*

Ferro-electric properties exist in two classes of materials. In one class, comprising Rochelle salt and its isomorphic crystals, Ca arsenate and Ca phosphate, the ferroelectric properties are determined by the type of H bond. Distances between Ti and H ions, also Curie temperatures, varying with dipole moments, are listed for the second group, including titanates of Cd, Sr, Ba and Pb. Their solid solutions belong to this group together with Pb zirconate.

J. LUKASZEWICZ

537.226.2

**4953. On dissociation processes in certain gases of high dielectric strength.** J. W. Warren, W. Hopwood and J. D. Craggs. *Proc. Phys. Soc., Lond. A*, **63**, 180–5 (*March*, 1950).

The dissociation processes, due to electron collisions, in certain polyatomic gases such as $CCl_4$, $CCl_2F_2$ are discussed with reference to their unusually high dielectric strength. Possible explanations are suggested in terms of these dissociation processes. A.

537.226.2 : 548.0

**4954. Preparation and investigation of $BaTiO_3$ single crystals.** H. Blattner, W. Känzig and W. Merz. *Diss. E.T.H. Zürich*, 31 *pp.* (1949) *In German.*

The preparation of single crystals of $BaTiO_3$ of the usual tetragonal form is described, as well as crystals of hexagonal and orthorhombic form. These latter have different dielectric properties from the tetragonal crystals. The permittivity, resonance frequency and specific heat are measured as a function of temperature: the Curie point is at 120°C, and peaks in the permittivity-temperature and specific heat-temperature curves occur at about 5°C as well as at 120°C. The crystals have ferro-electric properties, domains of spontaneous polarization at right angles to each other being observed: E. RUSHTON

537.226.2 : 621.3.011.5 : 621.319.4

**4955. Ice polarization.** R. E. Averbukh and M. S. Kosman. *J. Exp. Theor. Phys., USSR*, **19** 971–2 (*Nov.*, 1949) *In Russian.*

The strong dependency of permittivity of ice on temperature and on frequency of applied voltage is well known. A new ballistic method was used in d.c. tests on a condenser of semi-crystallized ice, 425 cm² in area, 0·5 cm thick. Results show that this permittivity has (1) a h.f. component, relatively small, independent of time of discharge and of polarity of the applied voltage; (2) a l.f., predominant component, strongly dependent upon time of discharge, polarity and temperature. Magnitude of applied voltage has a negligible effect. Barium titanate has similar properties. J. LUKASZEWICZ (R.)

537.226.2 : 621.314.26 : 621.319.4

**4956. Aperiodic frequency-doubling by means of "pluri-terminal" titanite capacitors.** A. A. Pascucci and H. W. Stawski. Letter in *Nature, Lond.*, **165** 441 (*March* 18, 1950).

Titanite ceramic dielectrics show a marked dependence of permittivity upon a.c. or d.c. field strength due to dielectric saturation and hysteresis. It is shown that the dependence holds for fields applied normal to as well as parallel to the measuring field. A 4-terminal capacitor was formed by metallizing 4 faces of a cube of titanite ceramic. If an alternating voltage of frequency $f$ is applied across two faces, a signal of frequency $f$ with a superposed harmonic of $2f$, is observed across the second pair of faces. Under suitable conditions of biasing the fundamental may disappear from the output. This frequency-doubling is explained by consideration of an equivalent bridge circuit which is balanced at $f$ when suitably biased. W. T. BLACKBAND

537.226.2 : 621.315.61

**4957. Titanate ceramics for electromechanical purposes.** H. Jaffe. *Industr. Engng Chem.*, **42**, 264–8 (*Feb.*, 1950).

A brief account is given of the high dielectric constants of $TiO_2$ and the alkaline earth titanates. The dielectric properties of these materials are analogous to the magnetic properties of iron, and in particular they show a pronounced electrical hysteresis. This effect is due to the internal polarization of the titanate crystals. The titanates have unusual electromechanical properties. An applied electric field produces a deformation proportional to its square root. A small alternating field superposed will produce additional distortion essentially proportional to the a.c. signal. The internal polarization produced by the steady field persists when the field is removed, and the proportionality of alternating field and deformation also continues. The resulting polarized block of Ba titanate behaves as a piezoelectric crystal of high sensitivity and high coupling coefficient. The piezoelectric properties of several substances are tabulated for comparison. Ba titanate can be formed into any desired shape, and as it can be polarized along any desired axis, it is possible to form ceramic transducers which focus their output. It is likely that such transducers will be used in industrial applications of ultrasonic energy. W. T. BLACKBAND

537.226.2 : 621.315.612.8

**4958. The ferro-electricity of titanates.** G. H. JONKER AND J. H. VAN SANTEN. *Philips Tech. Rev.*, **11**, 183–92 (*Dec.*, 1949).

"Ferro-electric" behaviour is ascribed to non-linearity between induced electric moment and field strength occurring below a critical Curie temperature and to the existence of hysteresis, i.e. the permittivity for an increasing applied field is lower than for a decreasing field. It is explained, however, that the analogy with ferromagnetism is not exact. Whereas ferro-electric behaviour is attributable to the tendency of electric dipoles to orientate each other by interaction, ferromagnetism can only be understood by quantum mechanics. Barium titanate and allied compounds are ferro-electric and their properties are discussed. They have a relatively simple cubic (perovskite) structure (alkaline earth ions at corners, Ti-ions at the face-centres and Ti-ions at the cube centres). The effective permittivity of $BaTiO_3$ rises to a max.($\varepsilon_{max}$) of the order of 10 000 at the critical Curie temperature $T_c$. Dielectric losses are small for temperatures above $T_c$ but are high below $T_c$ because of the hysteresis. The electrical properties of the titanates are shown to be a consequence of their crystallic structure. In practical applications the temperature range of the pure titanate over which $\varepsilon_{max}$ is attained is about 20–30°C; this can be increased to 40–50°C by admixture of other substances at the cost of the height of the max. The range can be further extended by using combinations of two kinds of mixed crystals containing different proportions of $SrTiO_3$ and $BaTiO_3$. Since hysteresis is present in the region of $\varepsilon_{max}$ the dielectric loss is high; for this reason, although the high permittivities find useful application for reducing the size of capacitors for coupling purposes, such capacitors are unsuitable for tuning circuits. A. M. THOMAS (R)

537.226.2 : 621.365.92

**4959. The physical basis of the dielectric heating of electrical non-conductors.** F. WALTER. *Frequenz*, **3**, 299–306 (*Oct.*, 1949) *In German.*

The dielectric properties of materials are discussed with reference to polarizability and permittivity, and equations are developed to show the relations between the quantities involved. The laws governing the propagation of the energy of electric waves are deduced in vectorial form. This propagation is affected by the energy absorption, while the phase angle between the electric and magnetic vectors varies with the absorptive power of the material. These results are applied to the heating of semi-conductors to give an expression for the heat developed. E. H. DOCK (R)

537.226.8–972 : 539.133

**4960. Measurements of electric dipole moments by microwave resonance method.** G. W. EPPRECHT. *Z. angew. Math. Phys.*, **1**, (*No.* 2) 138–44 (1950).

Gas dielectric constants at 9 400 Mc/s were measured by a method which involved altering the pressure of $O_2$ so as to adjust the frequency of an $O_2$-filled cavity resonator to equal that of a similar resonator filled with the polar gas. Dipole moments obtained from the temperature coefficients were: $O_3$: 0·52 *D*; $Cl_2F_2$: 0·55 *D*; $CClF_3$: 0·39 *D*. D. H. WHIFFEN

537.228.1

**4961. The dispersion of the piezoelectric modulus in Rochelle salt crystal at low frequencies.** H. KAWAI AND M. MARUTAKE. *J. Phys. Soc. Japan*, **4** (*No.* 2) 91–3 (*March–April*, 1949).

537.228.1

**4962. Piezoelectric effects in X-cut crystals.** A. GONZÁLEZ DEL VALLE. *An. Real. Soc. Esp. Fis. y Quím.*, **45A**, 462–5 (*Sept.–Oct.*, 1949) *In Spanish.*

## ELECTRIC CONDUCTION . CURRENTS 537.3

537.3

**4963. Noise in current-carrying ohmic conductors.** B. MELTZER. *Phil. Mag.*, **41**, 393–8 (*April*, 1950).

The mean-square noise current in a conductor which is in temperature equilibrium and carries a current $I$, is calculated on the assumption that the current is due to elementary carriers of charge $e$. The value obtained for the spectral density is $\{(2kT/R) + [(2kT/R)^2 + (2eI)^2]^{\frac{1}{2}}\}$, where $R$, $T$, $k$ are respectively resistance, absolute temperature and Boltzmann's constant. The interpretation of this result is that, over and above the ordinary thermal Nyquist noise, there is present an additional noise, of which the spectral density varies in square-law fashion according to $(e^2R/kT)I^2$ for small $I$, and in linear fashion according to $\{(-2kT/R) + 2eI\}$ for large $I$. These predictions are compared with Bernamont's experimental results for thin metallic conductors, and the discrepancies are discussed. A.

537.311 : 539.11

**The electron history and the relaxation time problem in the electron theory of solid conductors.** *See Abstr.* 5179

537.311.1 : 621.38

**4964. Thermal noise at high frequencies.** A. VAN DER ZIEL. *J. Appl. Phys.*, **21**, 399–401 (*May*, 1950).

Spenke's discussion [*Wiss. Veröff. Siemens-Werk.* **18**, 54 (1939)] of thermal noise from the point of view of the electron theory leads to a result which differs from Nyquist's original formula at frequencies $\nu$ such that $h\nu/kT \geqslant 1$. This discrepancy is due to the assumptions which Spenke made in his analysis. A.

537.311.31 : 537.312.8 : 538.632

**4965. Electric resistance, magneto-resistance, and Hall effect, of the alkali metals.** E. JUSTI. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 183–98 (1948) *In German.*

The electrical properties of carefully outgassed specimens of the alkali metals were measured over a wide temperature range from 300°K downwards. For purest Na, the resistivity is 0·244% of its value at 273°K at the b.p. of liquid He, and 0·17% at 0·73°K. For K the values are 0·475% and 0·056% at 4·22° and 0·77°K respectively. It is considered that superconductivity may become possible at these low temperatures. Similar results are quoted for Rb, Cs and Li. The effects of longitudinal and transverse magnetic fields up to 40 000 oersteds were determined. The Hall constants for the metals were measured over the same temperature range and were found to be substantially independent of field strength

and temperature. The experimental results are interpreted in terms of the band theory of metals, with special reference to the work of Kohler.

C. A. HOGARTH

537.311.32

**4966. On ionic conduction and defects in silver bromide with substituted divalent cations. I. Conductivity measurements and composition diagrams.** J. TELTOW. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 63–70 (1949) *In German.*

The electrical conductivity, $\sigma$, of solid AgBr with substituted $CdBr_2$, $PbBr_2$, $CaBr_2$ and $ZnBr_2$, was determined for homogeneous mixed-crystal specimens at various temperatures. By this means the influence of the doubly-charged cations on the normally singly-charged ionic lattice could be examined. For small quantities of impurity $\sigma$ falls, but for larger quantities it rises again. By extrapolation $\sigma$ for the purest AgBr is found to be $4\,800\times10^{-4}$ ohm$^{-1}$ cm$^{-1}$ at 410°C, $40\times10^{-4}$ ohm$^{-1}$ cm$^{-1}$ at 250°C, and $2{\cdot}1\times10^{-4}$ ohm$^{-1}$ cm$^{-1}$ at 175°C. C. A. HOGARTH

537.311.32

**4967. On ionic conduction and defects in silver bromide with substituted divalent cations. II. Quantitative significance of the conductivity isothermals.** J. TELTOW. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 71–88 (1949) *In German.*

The results of Abstr. 4966 (1950) are used to calculate the mobilities of the substituted divalent ions, and of other defect centres, and are further discussed in an extension of the Debye–Hückel–Onsager theories of association and other effects in strong electrolytes. C. A. HOGARTH

537.311.33

**4968. Investigations of photo-effects in semiconductors.** L. SOSNOWSKI. *C.R. Soc. Sci. Lett. Varsovie, Cl. III, Sci. Math. Phys.*, 82 *pp.* (1949) *In Polish.*

A new method of preparation of photoconductive and photovoltaic PbS cells is described. A new type of photovoltaic effect has been discovered in which the e.m.f. is generated in a layer of the semiconductor. A theory is advanced to explain the photo-effects occurring in thin layers of semiconductors. An explanation of photoconductivity is sought by attributing controlling influence to intercrystalline contacts in the sensitive layer. Theoretical values for conductivity, rectification, sensitivity, photo-e.m.f. and the time of response are in satisfactory agreement with experimental data. F. LACHMAN

537.311.33

**4969. The behaviour of the electric conductivity of some semi-conductors at the time of passing through a state of transformation or transition.** J. JAFFRAY. *C.R. Acad. Sci., Paris*, **230**, 525–7 (*Feb.* 6, 1950) *In French.*

In addition to various methods, mostly thermal, of determining the transition points of a pure material, an electric method is described using the conductivity as a criterion. Abrupt changes in the electric conductivity indicate the transition points. $HgI_2$, $KNO_3$, $NaNO_2$, $NaNO_3$ have been investigated. Under certain conditions $\log C = A - B/\theta$ where $C$ = conductivity, $\theta$ is absolute temperature and $A$ and $B$ are constants. W. SUMMER

537.311.33

**4970. Accumulation of the electrons of a semiconductor at the organic dyes adsorbed on it.** E. K. PUTSEĬKO AND A. N. TERENIN. *Dokl. Akad. Nauk SSSR*, 70 (*No.* 3) 401–4 (1950) *In Russian.*

A modification of a method used in previous research [*J. of Phys. Chem., USSR*, **23**, 677 (1949); *ibid.*, **22**, 1172 (1948); *Dokl. Akad. Nauk SSSR*, **67**, 1009 (1949); Abstr. 3229 (1949)] has enabled the authors to detect new and unexpected relationships between the internal photo-effect of the semi-conductor and the photoelectric activity of the adsorbed dye. Tl halogenides were used. It was found that the sensitized photo-effect of TlI dyed with methylene blue was considerably increased if along with an intermittent monochromatic illumination within the absorption spectrum of the adsorbed dye, a constant illumination with violet and blue lines (4 358 and 4 047 Å) of a d.c.-fed Hg lamp was employed. TlI dyed with erythrosin or eosin, or ZnO dyed with methylene blue did not show the above effect. This effect observed with TlCl and TlI (but not with TlBr) is explained by surface localization of the levels of electron capture and by a smaller depth of these levels below the conductivity zone. F. LACHMAN

537.311.33

**4971. Electron bombardment conductivity in diamond. II.** K. G. MCKAY. *Phys. Rev.*, **77**, 816–22 (*March* 15, 1950).

Previously published results [Abstr. 2503 (1949)] have been revised by the use of an improved alternating field method of internal space-charge neutralization. In addition lower limits are set for the mobilities of electrons and positive holes at room temperature. Measurements have also been made of the decay of current due to internal space-charge fields which are in reasonable agreement with theory. Finally, a double-pulsing technique is used to provide a novel method to study the rates of release of positive holes and electrons from traps. A.

537.311.33

**4972. On the conduction of electricity in semiconductors.** F. STÖCKMANN. *Naturwissenschaften*, **37** (*No.* 5) 105–11 (1950) *In German.*

Continuation of a previous paper [Abstr. 4974 (1950)], surveying the properties of barrier layers between semi-conductors and metals, crystal triodes and photo-conductors. The tunnel effect, diffusion and diode theories of barrier layer rectification are discussed and the concept of positive hole injection is briefly introduced. Photo-conduction in ZnO as a function of O pressure is considered in some detail.

H. K. HENISCH

537.311.33 : 537.322

**4973. Electron conduction in non-metals.** G. BUSCH. *Z. angew. Math. Phys.*, **1** (*No.* 2) 81–110 (1950) *In German.*

Continuation of a previous publication [Abstr. 2449 (1950)] dealing in particular with the conductive mechanism in $Cu_2O$, SiC, Si and oxides with spinel structure. The activation energy of many semiconductors is found to be a function of their impurity content. An interpretation of this relation is proposed

ch takes account of the energy necessary for the duction of lattice defects. The relation between ivation energy and dielectric constant of the lattice lso discussed, as is the effect of mechanical pressure the conductivity. Experimental and theoretical ults on the thermo-electric properties of semi-nductors are surveyed, with special reference to O and SiC. H. K. HENISCH

537.311.33 : 538.632

**4. On the conduction of electricity in semi-ductors.** F. STÖCKMANN. *Naturwissenschaften*, (*No.* 4) 85–9 (1950) *In German.*

First part of a comprehensive summary of semi-nductor properties and theoretical interpretations, ling particularly with a brief historical survey, initions and the principal bulk properties of semi-nducting materials. The temperature-dependence conductivity and the influence of impurities on nductivity and Hall effect are discussed in some ail, with special reference to Ge, PbS and Si.

H. K. HENISCH

537.311.33 : 621.314.63 : 621.315.59

**5. Characteristics of transistors.** P. AIGRAIN o C. DUGAS. *C.R. Acad. Sci., Paris*, **230**, 377–8 *n.* 23, 1950) *In French.*

Theory given in previous notes [Abstr. 4084–5 50)] is extended to explain transistor mechanism, ticularly the manifold increase of collector current npared with emitter current which is assumed e to positive hole current through the potential rier near to the collector. Agreement of the ntitative relations between emitter and collector rents with experimental data is claimed to be od. G. F. J. GARLICK

537.311.33 : 621.314.634 : 621.317.335.2

**6. Capacitance measurements on selenium recti-s: evidence of anomalous dispersion.** R. COOPER. *oc. Phys. Soc., Lond. A*, **63**, 176–9 (*March*, 1950).

Presents evidence showing that, contrary to the nerally accepted view, the capacitance of a Se tifier at a.f. may vary with the frequency of asurement. The magnitude of the variation pends on the metal used as counter-electrode. us in the range 300–2 000 c/s little variation occurs h Sb or Bi, but with Cd there is a considerable rease in capacitance. The effect is attributed to larization arising from the relative motion in the lattice of the negatively-charged impurity centres d positive ions which diffuse into the Se from the nter-electrode. A.

537.311.33 : 621.315.59

**7. Semiconductive colloidal suspensions with non-ar properties.** H. E. HOLLMANN. *J. Appl. Phys.*, 402–13 (*May*, 1950).

Semi-conductive particles in a colloidal suspension, en subjected to an electric polarizing field, form ni-conductive chains. Once the suspension is larized, its conductivity increases with increasing ds because the forces of electrostatic attraction ss the individual particles together, thus strengthen-the transition contacts along the chains. Both cts result in an over-all electric non-linearity that the subject of extensive investigation. The non-ar characteristics of such colloidal resistors are oscillographed and described in relation to the polarizing field strength by means of simple formulae based on field coefficients of the 1st and 2nd order. In addition to a true rectification, resulting from the curved characteristics, a "pseudo-rectification" occurs which corresponds to an average pre-polarization by stronger alternating fields. The alternating forces of electrostatic attraction assure a high-frequency response, so that non-linear Lissajous-figures and harmonics, up to radiofrequencies, are produced. A.

537.311.4

**4978. Dynamical method of investigating an electrical contact.** S. Z. KHAIKIN, G. K. DEMISHEV AND A. E. SADOMONOVICH. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 4) 609–11 (1950) *In Russian.*

537.312.5 : 537.311.3

**4979. The band model and the inertia of photo-electric conductivity in insulators and semi-conductors.** J. FASSBENDER, F. MÖGLICH AND R. ROMPE. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 327–32 (1948) *In German.*

Previous workers have already shown that primary and secondary photo-effects can be explained on the basis of the band theory of solids. In the present paper the concentration of free electrons for a given intensity of incident radiation is calculated as a function of time. The times necessary for the establishment of equilibrium as well as their temperature dependence can thus be evaluated in terms of the band structure of the lattice concerned.

H. K. HENISCH

537.312.5

**4980. On the electrical conductivity of zinc oxide.** E. MOLLWO AND F. STÖCKMANN. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 223–9 (1948) *In German.*

Specimens of ZnO $\frac{1}{2}\mu$ to 0·001 cm thick were produced by the oxidation in air of layers of vacuum-evaporated Zn, and used in room temperature measurements of electrical conductivity and photo-conductivity. The specimens were strongly yellow in colour and chemical analysis confirmed a stoichiometric excess of Zn. The conditions for the formation of the layers and their composition are discussed in the light of previous work on sintered specimens, such as that of Miller [Abstr. 783 (1942)] and Baumbach and Wagner [*Zeit. f. Phys. Chem.*, **22**, *Abt. B*3, 199–211 (*July*, 1933)]. The photo-conductivity is found to vary with time for the first 10 to 15 sec after irradiation of the specimens, and to peak at 435 m$\mu$ for yellow ZnO and at 385 m$\mu$ for white ZnO. C. A. HOGARTH

537.312.5

**4981. Quantitative work on the photo-conduction in zinc oxide.** E. MOLLWO. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 230–9 (1948) *In German.*

Specimens of ZnO as prepared above [Abstr. 4980 (1950)] were found to have a high optical absorption, cutting off at 385 m$\mu$. The variation of electrical conductivity $\rho$ with electric field and with time of optical irradiation of various wavelengths and intensities is investigated, and the results interpreted in terms of times taken for the excess electrons to react with the lattice defects. The "dark" conductivity at room temperature could be brought to a predetermined value for the beginning of an experiment by treating with oxygen. C. A. HOGARTH

537.312.5

**4982. A quantitative interpretation of the electrical and photo-electric conductivity of zinc oxide on the basis of the law of mass action.** E. MOLLWO AND F. STÖCKMANN. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 240–54 (1948) *In German.*

The authors' previous results [preceding Abstr.] are discussed and analysed in terms of the free-electron theory, and of various possibilities for defects to occur in the wurtzite lattice structure; it is assumed that the excess Zn exists as $Zn^+ + e$, the effect of light absorption being to form $Zn^{++} + 2e$.

C. A. HOGARTH

537.312.5

**4983. A new contribution to the theory of photo-electric cells of the barrier layer type.** G. LIANDRAT. *Istanbul Univ. Fen. Fak. Mec.*, **12**, 127–50 (*April*, 1947) *In French.*

The various hypothesis on Se and copper oxide photovoltaic cells are discussed and it is shown that the primary effect is an electronic emission originating in the semi-conductor. On the one hand, the photo-current is $\propto$ the incident flux, but on the other hand, diminishes as a function of the counter-e.m.f. which is set up between the surfaces of the Schottky layer. At the same time, the conductivity increases as a function of the potential difference and of the luminous flux. An explanation of these apparently contradictory facts is attempted by assuming that the photoelectric potential difference is not a direct measure of the primary energy.

W. SUMMER

537.312.5

**4984. Calculating the electron mobility in CdS single crystals under modulated light.** J. FASSBENDER AND H. LEHMANN. *Ann. Phys., Lpz.*, **6**, 215–28 (1949) *In German.*

The photoconductivity of synthetic CdS single crystals has been measured in relation to the intensity, wavelength and modulation frequency of the incident light. The photocurrent is a function of the mobility ($b$) and concentration ($n$) of the electrons in the conductivity band. The latter is a function of the absorbed light energy and of the recombination coefficient ($\alpha$). The new values for ($b, n, \alpha$) are smaller than those previously accepted which is in accordance with Schottky's theory.

W. SUMMER

537.312.5

**4985. On photoelectric conduction in PbS.** H. PICK. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 255–69 (1948) *In German.*

A chemical reaction is given for the production of highly sensitive PbS photoelectric layers of about 1 $\mu$ thickness. The spectral sensitivity extends from 3 000–35 000 Å at + 20°C and to almost 40 000 Å at − 180°C. It has been found that the life of the electrons is inversely $\propto$ the concentration of photo-electrons (intensity of radiation) and to the temperature of the PbS layer. The sensitivity also increases with decreasing temperature.

W. SUMMER

537.312.5

**4986. Photoelectric effects in Proustite crystals.** M. ÖGDER. *Istanbul Tek. Üniv. Bül.*, **2** (*No.* 1) 55–66 (1949) *In German.*

The total photoelectric potential is composed of the barrier layer photoeffect, the crystal and the contact photoelectric effects. The polarity of th constant photoelectric potential is that of the maj of these effects. A polarization effect is noticeabl making the voltage a function of time. In crysta having a barrier layer the photoelectric potentia are rather high. In a front-wall type crystal th barrier layer photoeffect and the crystal photoeffe act in the same sense and the photoelectric potenti is relatively high. In a back-wall type crystal th two effects act in the opposite sense and the phot electric potential equals the difference of the tw The contact photoeffect opposes the crystal phot effect.

W. SUMME

537.312

**4987. On the photoelectric properties of CdS sing crystals.** J. FASSBENDER. *Ann. Phys., Lpz.* (*Folge* 6) (*No.* 1–2) 33–50 (1949) *In German.*

This effect is interpreted by the theory of atom energy levels and by applying to the photoelectron the principles of metallic conductivity. A relationshi is shown to exist between photoelectric curren coefficient of absorption, and thickness of the laye The selective maximum is a function of the bi molecular recombination process.

W. SUMME

537.312

**4988. On the mechanism of the photo-conductiviti of copper oxide.** V. P. ZHUZE AND S. M. RYVKIN *Dokl. Akad. Nauk, SSSR*, **68** (*No.* 4) 673–6 (1949) *Russian.*

An attempt to explain some incongruities in th result of some previous work by Ryvkin [Abstr. 246 (1950)]. A zonal scheme is suggested, based on th "hole" character of the dark conductivity, hole being created in the lower zone by a thermal transfe of a part of the electrons to the acceptor levels of the C The photo-conductivity is then produced by a transfe of the electrons under the influence of light from th acceptor levels into the higher zone. The photo effects would thus have an accidental character.

B. F. KRAU

537.312.

**4989. The relaxation of the photoconductivity o thallium sulphide.** D. B. GUREVICH. *Dokl. Akad Nauk, SSSR*, **69** (*No.* 6) 781–3 (1949) *In Russian.*

A $Tl_2S$-photoresistance has been investigated usin the method of Tolstoĭ and Feofilov [Abstr. 16 (1950)].

F. LACHMA

537.312.

**4990. A relationship between the refractive index and the infra-red threshold of sensitivity for photo conductors.** T. S. MOSS. *Proc. Phys. Soc., Lond. A* **63**, 167–76 (*March*, 1950).

It is shown that for photoconductive compound the long wavelength "threshold" of sensitivity should be related to the refractive index $n$ of the photoconductor, and analysis of the available data shows that for the more highly refractive compounds $n^4/\lambda$ always has a value close to 77. As a consequence of this relation, an explanation can be given for the change of the threshold wavelength with temperatur which is observed for PbS and similar materials. Suggestions are made as to what materials ought to be suitable for photoconductive detectors at longe wavelengths in the i.r., and some confirmation of the

as is shown by results obtained with $Cd_3As_2$, the operties of which are briefly described. A.

537.312.5 : 535.215 : 537.58

**Photo-electric work function of Ag films.** *See* *nstr.* 5076

537.312.5 : 537.542

**91. Multiplication effect in electrical conductivity of cadmium sulphide crystals due to irradiation by alpha particles, electrons and gamma rays.** H. ALLMANN AND R. WARMINSKY. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 1–2) 69–84 (1948) *In German.*

Measurements were made of conductivity in single ystals of CdS due to α-, β- and γ-ray bombardment. rong conductivity occurs in highly luminescent ystals and is ≫ expected from number of secondary ectrons released. After bombardment the multiplication effects persist and are assumed to be due to phosphorescence electrons" having long excited es and high mobility. Short-lived conduction ulses with high multiplication factor only occurred a few crystals. For single α-particles pulses of V magnitude were obtained and pulses due to ngle electron transits in crystals could be detected. urface bombardment with α-particles must be near — ve electrode to give large pulses, this being nsistent with electronic conduction. Subsequent celeration of electrons to the + ve electrode accounts r field dependence of output pulses, an effect not bserved for volume excitation of the crystals with nergetic β-rays. Conductivity pulses are decreased y a factor of 10 when crystal is previously irradiated ith i.r. radiation, but enhanced when irradiated with isible light. Tentative theoretical explanations of the arious effects are given. G. F. J. GARLICK

537.312.62

**992. The Londons' theory for non-cubic superconductors.** M. V. LAUE. *Ann. Phys., Lpz.* (*Folge* 6) , 31–9 (1948) *In German.*

It is shown that the main features of the Londons' heory of superconductivity are preserved if $\lambda$ is onsidered as a second rank tensor rather than a calar. [See also Ginsburg, *J. Phys., USSR*, **8**, 148 1944)]. D. SHOENBERG

537.312.62

**993. Superconductivity and crystal class.** M. V. LAUE. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 40–2 (1948) *In German.*

In the extension of the Londons' theory to non-ubic crystals [see previous Abstr.] it was found ecessary that the tensor $\lambda$ should be symmetrical. t is pointed out that this symmetry is consistent with he actual crystal classes of all known superonductors. D. SHOENBERG

537.312.62

**994. Thermodynamic considerations about the roblem of superconductivity.** W. HEISENBERG. *Ann. hys., Lpz.* (*Folge* 6) **3**, 289–96 (1948) *In German.*

From the empirical behaviour of the specific heat ertain conclusions are drawn about the electronic ondensation phenomenon assumed to occur in the uperconducting transition. The thermoelectric effects re discussed and the electric field calculated which ust occur in the presence of a temperature gradient. he behaviour of a rotating superconductor is discussed in connection with the thermodynamics of the Meissner effect. D. SHOENBERG

537.312.62

**4995. Cooling and switching-on processes in superconductors according to von Laue's theory.** G. U. SCHUBERT. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 3–5) 213–36 (1949) *In German.*

Using von Laue's form of the Londons' equation two problems are discussed. Firstly, the exclusion of the magnetic field when superconductivity is produced by lowering the temperature (the time variation of penetration depth is taken into account), and secondly the establishment of the exclusion of a magnetic field which is suddenly applied to a superconductor at constant temperature. D. SHOENBERG

537.312.62

**4996. On one of Heisenberg's hypotheses in the theory of specific heat of superconductors.** K. F. NIESSEN. *Physica*, **16**, 77–83 (*Feb.*, 1950).

An assumption made by Heisenberg [Abstr. 4994 (1950)] in Koppe's theory of the specific heat of superconductors is discussed. A comparison with another problem at first sight seems to contradict this assumption, but turns out to support it. Heisenberg's assumption is also confirmed in a direct way. A.

537.312.62

**4997. The energy of the normal electrons in a superconductor as a function of temperature and thickness of the superconducting layer on the Fermi surface.** K. F. NIESSEN. *Physica*, **16**, 84–94 (*Feb.*, 1950).

To simplify calculations Heisenberg's assumption about the superconducting layer covering a part of the Fermi surface is modified in so far that a layer is assumed of thickness $\Delta$ (by which is meant the difference of the energies corresponding to the upper and lower surfaces of the layer), which layer, covering a part $\omega$ of the Fermi surface, is entirely inaccessible to normal electrons. A formula for the energy of the normal electrons is derived which is a function of $\omega$, $T$ and $\Delta$ and which for $\Delta \gg kT$ coincides with Koppe's expression in the Heisenberg theory but for $\Delta \ll kT$ is identical with the value well known from Sommerfeld's theory of metals. A special case is used to express the number of superconducting electrons per cm³ at $T = 0$ in the transition temperature and the number of normal electrons. A.

537.312.62

**4998. Superconductivity of uranium.** B. B. GOODMAN AND D. SHOENBERG. Letter in *Nature, Lond.*, **165**, 441–2 (*March* 18, 1950).

Two specimens of $U$ became superconducting at about 0·75°K, while others (less pure) became superconducting at about 1·3°K in agreement with previous work of Justi. Some observations of the magnetic field required to destroy superconductivity and of the specific heat are also reported. D. SHOENBERG

537.312.8

**4999. Change of resistance of Sn and In in a magnetic field.** E. S. BOROVIK. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 767–9 (1949) *In Russian.*

The change of resistance of Sn and In crystals in transverse magnetic fields up to 20 000 gauss at liquid He temperature has been studied. For In at

4·2°K the increase $\Delta R/R$ was only about 1 and not sensitive to crystal orientation. For a Sn crystal with its length parallel to a binary axis $\Delta R/R$ varied from 100 to about 6 as the angle between the field (15 000 gauss) and the tetragonal axis was varied. At the minimum, the field variation of $\Delta R/R$ showed a dip at about 5 000 gauss. The behaviour did not vary greatly between 4·2°K and 2·2°K.

D. SHOENBERG

537.312.8 : 538.63

**5000. Theory of magnetic resistance effects in metals.** M. KOHLER. *Ann. Phys., Lpz.* **6**, 18–38 (1949) *In German.*

These are considered generally for a simple 2-band model without specifically including the scattering mechanism. The fundamental statistical equation is solved generally. Approximational expressions for electrical and thermal resistance changes in transverse magnetic fields are derived and their general character verified for pure W and Be. The Grüneisen method for determining lattice conductivity in transverse fields is verified in certain cases. The derived small absolute values for metals at low temperatures are related to an increase of the interaction between electrons and lattice waves as compared to that in insulators. It is concluded by systematic investigation that lattice structure as well as valency electron concentration is important in determining the conductivity character ("type") of metals.

E. P. WOHLFARTH

537.312.8 : 538.63

**5001. Magnetic resistance change and conductivity types. I.** M. KOHLER. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 89–98 (1949) *In German.*

From general electron-theoretical considerations it is shown that the behaviour of the bivalent metals in the very strong magnetic field is homogeneous. Without special premises on the electron-lattice interaction, the electronic energy-state distribution or the crystal structure, it is deduced that in the limiting case of the very strong magnetic field the electrical resistance increases as the square of the magnetic field. Accordingly, these metals become insulators on extrapolation to $H = \infty$. The assumptions essential for this general result are: (1) the number of the cavities in the first energy band is exactly equal to the number of the electrons in the second band; (2) the overlapping of the two energy bands is not too great; (3) complete degeneration of the electron gas. The behaviour of these metals in the magnetic field evidently arises from the fact that the Hall field strength becomes small and no longer exerts an increasing conductivity effect. [See also following Abstr.]

H. G. SOLOMON

537.312.8 : 538.63

**5002. Magnetic resistance change and conductivity types. II.** M. KOHLER. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 99–107 (1949) *In German.*

The electrical resistance and the Hall coefficient of univalent metals of cubic crystal symmetry in the very strong magnetic field are investigated on similar lines for the bivalent metals [see preceding Abstr.]. Both show saturation in respect to the dependence on the magnetic field. The Hall coefficient is generally isotropic. Simple conditions exist when the limiting energy surface does not reach the surfaces of th Brillouin zone. In this case the transverse resistanc change is isotropic and the longitudinal at mos equals the transverse. The Hall coefficient is equa to the value for free electrons. From the empirica anisotropy of the resistance change in most univalen metals it can be concluded that the limiting energ surface at least approaches the surface of the Brillou zone. This would not be the case for free electron K appears to form an exception. From the new experiments by Justi of the Hall coefficients of th alkali metals the bond effect of these metals appear much stronger than hitherto suspected. Experimenta Hall coefficients are tabulated together with cal culated values for free electrons for Au, Ag, Cu, N and K. Maximum values obtained experimentall for $\xi = A_H \cdot \rho_0 \cdot H$ for Au, Na, K and Li are give in a second table.

H. G. SOLOMO

537.312.8 : 538.63

**5003. On the change of the resistance of single crystals of gallium in a magnetic field.** J. W. BLOM *Physica*, **16**, 144–51 (*Feb.*, 1950).

For single-crystals of Ga, with the shorter crysta axes parallel to the current, the rotational diagram giving the increase of the resistance $\Delta R_H$ in a mag netic field as a function of the orientation of the field with respect to the current, are simple sine-curves As in the case of the $P_1$-crystals (with the long axis parallel to the current) $\Delta R_{||}$ shows, in contrast with the normal behaviour at liquid H temperatures, a diminishing influence of the field at high field strengths This suggests a saturation at still higher values of the field. Also $\Delta R_{||}/R_{0°C}$ decreases anomalously with decreasing temperature in the same manner as it does with the $P_1$-crystals.

A.

537.312.8

**5004. The Kohler diagram for the magnetic increase of the resistance of gallium single-crystals.** J. W. BLOM. *Physica*, **16**, 152–70 (*Feb.*, 1950).

On plotting the above measurements [preceding Abstr.] as Kohler diagrams, characteristic functions are found, both for the transverse and the parallel orientation of the field with respect to the current. This facilitates the observation of the results for different temperatures and also enables one to compare the measurements from a number of crystals. It is remarkable that for the transverse effect the trivalent Ga fits in with the bivalent Cd-type, introduced by Justi, and does not resemble the In-behaviour. For the parallel effect a saturation tendency exists, which is probably a general phenomenon.

A.

537.312.8

**5005. On the Fourier analysis of the magnetic increase of the resistance of gallium. The Fourier components in the Kohler diagram.** J. W. BLOM. *Physica*, **16**, 171–82 (*Feb.*, 1950).

Fourier analysis of the magnetic increase $\Delta R$ of the electrical resistance of single-crystals of Ga (with the longer axis parallel to the current) shows that the characteristics of the diagrams giving $\Delta R$ as a function of the orientation of the field at liquid N temperatures are related to the interchanging of the two shorter crystal axes. This is most probably connected with the anomalous behaviour of the

magnetic increase of the resistance when the field is perpendicular both to the current and to one of the shorter axes ($P_2$-axis). At liquid H temperatures, for the transverse effect, the term with a period of 60° gains an abnormal importance. When the angle between field and current is varied the saturation tendency in the parallel effect has a great influence in this temperature range. When plotted in a Kohler diagram characteristic curves are found for all coefficients. A.

537.313 : 539.185.08

**Change of resistance of Pd under recoil proton bombardment.** *See Abstr.* 5314

537.322

**5006. Peltier effect in monometallic contacts.** C. DIETRICH. *Z. angew. Phys.*, **2** (*No.* 3) 128–31 (1950) *In German.*

It was found that an effect analogous to the Peltier effect is observable in a monometallic contact, provided an impurity film is present. The effect disappears at high temperatures. Theory and experimental data are given. P. M. DAVIDSON

537.323 : 537.311.33

**5007. Thermoelectric power and mobility of carriers in selenium.** H. W. HENKELS. Letter in *Phys. Rev.*, **77**, 734–6 (*March* 1, 1950).

## ELECTRIC DISCHARGES 537.52

537.52

**5008. A movable probe for gas discharge experiments.** W. VON MEYEREN. *Z. Phys.*, **125** (*No.* 7–10) 539–40 (1949) *In German.*

537.521.7 : 545.82

**5009. On the physical cleaning of surfaces. I. Spectra of gliding sparks on contaminated glass surfaces.** K. KINOSITA, M. SUMI AND T. OWAKI. *J. Phys. Soc. Japan*, **4**, 30–3 (*Jan.–Feb.*, 1949).

The spectrograph of a spark over the surface of glass was observed for different methods of cleaning. The CN band was present in grease-covered surfaces, but not when the glass was chemically cleaned. There were traces of Ca and Na in the spectrum even when the glass had been chemically cleaned; this may be from the glass itself. The experimental method involves moving the glass slightly between successive sparks, and obtaining the effect of thousands of sparks on a single spectrogram. N. CORCORAN

537.523

**5010. Fluctuations of discharge parameter in predischarge currents; and measurements of fluctuations.** W. FUCKS. *Z. Naturforsch.*, **5a**, 89–98 (*Feb.*, 1950) *In German.*

The theoretical and observed dependence of discharge current $J$ on the gradient $[\partial J/\partial p]$ of the discharge parameter $p$ are discussed for corona and Townsend discharges at about atmospheric pressure. Experimental examples are given for discharges in which one electrode is made to undergo mechanical oscillations in order to vary a parameter. F. LLEWELLYN JONES

537.523.4

**5011. Electrode erosion by spark discharges.** F. LLEWELLYN JONES. *Brit. J. Appl. Phys.*, **1**, 60–4 (*March*, 1950).

Theoretical estimates of the areas of electrode hot-spots are made from a consideration of the lateral spread of the electrons and positive ions due to diffusion and their space charge. Areas thus found show that very high current densities of the order $10^6$ A/cm$^2$ are possible in typical short spark gaps at atmospheric pressure. The energy balance at such hot-spots for an equilibrium temperature equal to the boiling point of the electrode material is then considered and, neglecting chemical attack, an equation is set up relating the volume of electrode evaporated per spark (i.e. the spark erosion) to the physical properties of the electrode material. A.

537.525

**5012. The photosensitivity of neon lamps: the positive Joshi effect.** H. J. ARNIKAR. Letter in *Curr. Sci.*, **19**, 47–8 (*Feb.*, 1950).

537.525.6

**5013. Unstable oscillations in an electron gas.** K. G. MALMFORS. *Ark. Fys.*, **1**, *Paper* 30, 569–78 (1950).

Gives a mathematical treatment of a system of electrons moving with same velocity perpendicular to magnetic field. Instability arises; small primary distortions produce large statistical density variations accompanied by electric fields. Applications to theory of trochotron, solar fields and galactic noise are suggested. F. LLEWELLYN JONES

537.525.8

**5014. The diffusion theory of the positive column in electronegative gases.** R. SEELIGER. *Ann. Phys., Lpz.*, **6**, 93–6 (1949) *In German.*

Discusses the structure of a plasma in electronegative gases, and sets up the differential equations defining the structure in terms of diffusion coefficients and collision cross-sections, etc. J. D. CRAGGS

537.525.8

**5015. Positive ions in gas discharges.** R. L. F. BOYD. *Nature, Lond.*, **165**, 228–30 (*Feb.* 11, 1950).

Describes a new probe technique for the study of positive ion swarms in low pressure gaseous discharges, i.e. for the investigation of ion and electron temperatures and energy distributions. The new probe consists, for example, of a plane electrode screened with a wire grid (14 strands of 0·016 mm W) stretched across a 1 mm aperture. Characteristics taken with a 0·0009 mm press. discharge in A are shown in detail. A discussion of the formation of positive ion sheaths on negative electrodes is given. J. D. CRAGGS

537.525.8

**5016. The collection of positive ions by a probe in an electrical discharge.** R. L. F. BOYD. *Proc. Roy. Soc. A*, **201**, 329–47 (*April* 26, 1950).

Theoretical reasons are given for the view that the energy distribution of the positive ions at a sheath edge must comply with a certain criterion, and unless this criterion is fulfilled the probe will not be screened by a sheath but the field of the probe will penetrate into the plasma. The penetration of this field modifies

the energy distribution and concentration of the positive ions in the probe neighbourhood until, if the probe voltage is sufficient, the criterion is satisfied and a sheath forms. The probe potential necessary to bring this about has been calculated for idealized high- and low-pressure cases. The effect of the penetrating field on the saturation positive-ion current as predicted by the conventional theory has been calculated. Experiments with a small probe in the form of a grid with a collector behind it made it possible to obtain Langmuir probe characteristics in A with the electron, ion and secondary emission components separated from one another. The general predictions of the theory are confirmed. Observations have also been made upon the anisotropy of the ion and electron-energy distributions. A.

537.525.8 : 541.124

**5017. The formation of ozone in a positive column at low pressure.** P. J. Deegan and K. G. Emeleus. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 149–52 (1948).

## X-RAYS 537.531

537.531

**5018. Luminescence measurement of roentgen dosage.** B. Cassen and L. R. Curtis. *Nucleonics*, **6**, 34–8 (*Feb.*, 1950).

A small piece of polyvinyl carbazole was employed as an X-ray phosphor and the light was piped through a lucite rod to a photomultiplier. The arrangement was used to obtain the dosage distribution around the Be window of an X-ray tube. It was shown that the luminescence of the phosphor per r/min was approximately independent of the tube voltage and that the photomultiplier response was $\propto$ the X-ray intensity.

L. R. SHEPHERD

537.531 : 535.3

**5019. A self-recording ionization spectrometer for intensity measurements.** E. Laurila. *Ann. Acad. Sci. Fennicae, Ser. A*1 (*No.* 5) 11 *pp.* (1941) *In German.*

Describes an apparatus for the automatic recording of X-ray spectra, using a high pressure counting tube (for example, 0·9 atmos. of Xe), with a simple counting circuit. The source of radiation was a Müller–Metalix X-ray tube. Photographs and drawings of the apparatus are included, with a few representative spectra. J. D. CRAGGS

537.531 : 535.3 : 545.824

**5020. On the possibility of quantitative X-ray absorption analysis with an ionization spectrometer.** E. Laurila. *Ann. Acad. Sci. Fennicae, Ser. A*1 (*No.* 6) 14 *pp.* (1941) *In German.*

Describes expts. on quantitative analysis with X-rays, using the apparatus described in Abstr. 5019 (1950). The present method involves the observation of absorption limits obtained when the source radiation is passed through the specimen to be analysed. The elementary theory is given and, as an example, data obtained with mixtures of salts containing Br and Rb are quoted. J. D. CRAGGS

537.531 : 535.3

**5021. A proportional counter X-ray spectrometer.** W. Bernstein, H. G. Brewer, Jr. and W. Rubinson. *Nucleonics*, **6**, 39–45 (*Feb.*, 1950).

Describes the use of proportional counters with amplifier and single channel pulse analyser for measuring X-ray spectra in the range 1–50 keV. A typical counter employing 90% Ne, A or Kr + 10% $CH_4$ fillings at 1 atmos. pressure is described and details of an amplifier for handling pulses with height ratios of 7 000 : 1 is given. The counters are operated between 1 500–2 100 V with gas amplification $\simeq$ 1 000 and results are given showing that the pulse height varies exponentially with applied voltage in the operating range. Some results are given, including spectra of $Ba^{135}$ and $Se^{75}$, *K*-capture X-rays and fluorescent radiation from Mn, Fe, Ni, Cu, Zn and Zr targets irradiated by 17 keV X-rays. The latter are used to establish the linearity of pulse height *v.* X-ray energy of the spectrometer. L. R. SHEPHERD

537.531 : 535.343

**5022. The structure of the X-ray *K* absorption edge of nickel in solutions.** E. Vaĭnshteĭn. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 771–2 (1949) *In Russian.*

The fine structure of the X-ray *K*-absorption edge of Ni in molecules of various composition has been investigated in aqueous and alcoholic solutions.

F. LACHMAN

537.531 : 535.343

**5023. On the structure of the fundamental *K* absorption edge of atoms of transition elements in metals.** E. Vaĭnshteĭn. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 21–3 (1950) *In Russian.*

It is suggested that the structure of the fundamental absorption edge in a metal (alloy) is a superposition of two or more individual edges each of which is due to the transition of the *K*-electron of the given atom into the region of continuous energies and on to free optical levels which differ from one another for atoms differing in the degree of ionization. This theory explains some properties of ferromagnetic elements. It is probable (1) that atoms of Co, Fe and Ni are present in the respective metals as neutral atoms and as positive ions carrying one unit charge, and (2) that the ionization of atoms in a metal does not differ from the corresponding process in ionic compounds.

F. LACHMAN

537.531 : 535.4

**5024. On the deviation [Lenkung] of bundles of rays within atomic dimensions.** W. Kossel. *Ann. Phys., Lpz.*, **6**, 97–104 (1949) *In German.*

The analogy between Laue's dynamic theory of diffraction by crystals and the formation of standing waves on the macroscopic scale is developed, and elementary explanations of Bragg's law, Kikuchi lines, etc., given. A. J. C. WILSON

537.531 : 535.371.07

**5025. The energy yield of X-rays in the fluorescence of calcium tungstate.** J. Eggert and E. Schoppert. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 270–9 (1948) *In German.*

Quantitative measurements of the energy and quantum efficiency of $CaWO_4$ intensifying X-ray films have been made. The X-ray dosage and

orption coefficients were measured by ionization ers and use was made of the measurements of z [*Veröff. Agfa BdIV., Lpz.*, **26** (1935)] on the olute spectral sensitivity of X-ray film to X-rays of those of de Groot [*Philips Tech. Rundschau*, **3**, (1939)] on the spectral distribution of the emission $CaWO_4$ and the relative spectral sensitivity to t of the X-ray film used. It is found that the ntum efficiency decreases some hundredfold as wavelength decreases from 1·54 Å to 0·29 Å. is accounted for by the radiationless dissipation he exciting X-ray energy. An estimate of the ected efficiency in a given case agrees with practice llowance is made for the effect of photoelectrons ased by the X-rays and for the light losses in the nsifying film. J. EWLES

537.531 : 535.43

**6. Influence of the bonding electrons on the tering of X-rays by carbon.** R. E. FRANKLIN. er in *Nature, Lond.*, **165**, 71–2 (*Jan.* 14, 1950).

or a wide variety of carbons the observed intensity he (10) band is twice the theoretical value predicted Warren [Abstr. 1399 (1941)], otherwise agreement ood. This is explained by supposing that the e $sp^2$ electrons in a graphitic carbon are directed single plane, the layer plane, and are concentrated nd the centres of the C–C bond rather than at atomic nuclei. R. B. SHEPHERD

537.531 : 621.386.1

**7. On the working process of impulse X-ray s.** E. FÜNFER. *Z. angew. Phys.*, **2** (*No.* 1) 25–33 50) *In German.*

review, with drawings, of the principal types of s with cold and hot cathodes is given and their tion discussed. The theory of discharge in a lium vacuum [Steenbeck, *Wiss. Veröff. Siemens-k*, **17** (*No.* 4) (1938)] is extended and used to cal- te the effect of positive ions, neutralizing the ce charge, on current and voltage waveforms from ld cathode; the currents are many times those for space charge even at low pressures. Oscillo- ns of voltage and current for capacitances of and 10 000 cm are given, as well as waveforms of ay output using a photo-multiplier. The build-up lischarge is much slower than for a spark in air, ng about 1 $\mu$sec, and the duration of X-ray ssion is almost independent of capacitance, though ut increases nearly linearly with this. The sured currents are 20× theoretical values, due bably to the added production of positive ions by t in the discharge arc, and pulse duration is less n equal factor. F. T. FARMER

537.531 : 621.386.1

**8. Considerations in the design of demountable ay diffraction tubes.** R. I. GARROD. *J. Sci. rum.*, **27**, 89–93 (*April*, 1950).

description is given of two different types of s for crystallography. A.

537.531 : 621.386.2

**9. The first ceramic X-ray tube.** R. R. MACH- *Cath. Press*, **7** (*No.* 1) 2–5 (1949–50).

brief description of a new wide-angle tube for soft (4–25 kV) X-rays. Ceramic to metal seals are used. Electrons from a ring cathode are focused on to a concentric anode which faces the 1¼ in dia. Be window. A. H. W. BECK (R)

537.531 : 621.396.611.4 : 621.386.1.027.89

**5030. A million-volt resonant cavity X-ray tube.** B. Y. MILLS. *Instn Elect. Engrs, Paper No.* 924 (1950) 10 *pp.*

A very compact h.v. X-ray tube is described, in which the accelerating voltage is developed in a resonant cavity excited by a high-power magnetron operating at a wavelength of 25 cm. A mean current of 70 $\mu$A has been obtained at a peak voltage of 1·1 MV. The focal spot is very small (approximately ½ mm in dia.) and, because the output is pulsed, the tube may be used as a stroboscope for the radiography of moving machinery. The limitations which apply to this method of acceleration are discussed. A.

537.531.85 : 539.166.74

**Higher approximations to the Klein–Nishina formula by the theory of radiation.** *See Abstr.* 5254

## CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

**5031. On the theory of electron acceleration in an alternating magnetic field. I.** J. PICHT. *Optik*, **6**, 40–55 (*Jan.*, 1950) *In German.*

A theoretical treatment of the betatron. The basic equations are put in terms of the Hertzian vector. From these are derived the acceleration and stability conditions. W. I. B. SMITH

537.533

**5032. On the theory of electron acceleration in an alternating magnetic field. II.** J. PICHT. *Optik*, **6**, 61–97 (*Feb.*, 1950) *In German.*

An analytical treatment is made of various assumed magnetic field shapes for a betatron, including that in which a constant biasing field is present. Stability and focusing at injection is discussed, which leads to a system of generalized Mathieu differential equations. W. I. B. SMITH

537.533 : 615.849

**Possible techniques in direct-electron-beam tumor therapy.** *See Abstr.* 5402

537.533.71 : 548.74

**5033. On the anomalies of the small angle reflection of cathode rays from the surface of a single crystal. I. The usual dynamical treatment.** K. KOHRA AND K. SHINOHARA. *J. Phys. Soc. Japan*, **4** (*No.* 3) 155–9 (*March–April*, 1949).

A detailed theoretical treatment is given in order to study the anomalies of the small angle reflection of cathode rays from a cleavage face of rocksalt. It is shown that the correction formula of the positions of the reflection spectra by previous authors cannot be applied to the lowest order reflection. There are, moreover, serious discrepancies between the theoretically obtained feature of the lowest order reflection and that obtained experimentally. A.

537.533.71 : 548.74

**5034. On the anomalies of the small angle reflection of cathode rays from the surface of a single crystal. II. The investigation on the causes of the anomalies.** K. KOHRA AND K. SHINOHARA. *J. Phys. Soc. Japan*, **4**, 160–3 (*March–April*, 1949).

It is shown that the anomalies cannot be attributed to the effect of the azimuth nor the poorness of the approximation of the calculation, but can be explained, for the greater part, by a simple geometrical consideration. A.

537.533.72

**5035. The theory of electrostatic and magnetic diffusion of electron beams and the application of a perturbation method.** W. GLASER. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 7) 389–408 (1949) *In German.*

The perturbation method used for obtaining the results given in the author's 1938 paper [*Z. Phys.*, **111**, 357 (1938)] is described in detail, because it has been used in more recent publications [Wendt, *Z. Phys.*, **118**, 593; **119**, 423 (1942)] and has also been criticized [Picht, *Ann. Phys., Lpz.*, **43**, 62 (1943)]. The initial point and field are given, and the perturbation caused by a change in field calculated. Applications to purely electric and purely magnetic fields are considered, particularly for the case of large angle deflection. A comparison with the work of Picht is made. A. H. W. BECK

537.533.72

**5036. Remark on the work "Image formation and resolving power of the electron microscope from the standpoint of wave mechanics."** W. GLASER. *Z. Phys.*, **125** (*No.* 7–10) 541 (1949) *In German.*

Abstr. 2449 (1944).

537.533.72 : 621.385.833

**5037. An electron filter for electron microscopy and electron diffraction.** H. BOERSCH. *Optik*, **5**, 436–50 (*Oct.*, 1949) *In German.*

Describes the use of a reflecting field to remove the scattered electrons resulting from collisions in the object, thus improving the contrast. The necessary conditions for filtering are discussed and tests on a gridded reflector described. An Ag grid of $10^4$ mesh/cm$^2$ was used which effectively eliminated the scattering; the grid itself, however, was imaged on the screen. The grid image could be removed by deflecting the beam over the grid by means of an a.c. electromagnet, in which case good results were obtained. A. H. W. BECK (R)

537.533.72 : 621.385.833

**5038. The electrostatic lens as a velocity analyser of high resolving power.** G. MÖLLENSTEDT. *Optik*, **5**, 499–517 (*Nov.–Dec.*, 1949) *In German.*

The velocity distribution of the electrons in the beam is of interest for several reasons, e.g. the determination of the elements present in the object and the electronic energy levels. The 3-electrode "Einzellinse" can be used for velocity analysis if operated with a fine slit, slightly off the axis and extending over the whole aperture in the first electrode. The focal properties of the lens depend strongly on the radial co-ordinate at entry, so that the image of the slit is distorted to a, roughly, tan-function shaped curve. Small changes of velocity at entry displa this curve parallel to itself and so the device can used as a velocity analyser with resolving power better than $1 : 3 \times 10^4$. The experimental difficult encountered are described. Results for 35–40 k electrons passing through several materials are giv and the problem of the minimum amount of mater for a microanalysis is discussed. A. H. W. BECK

537.533.72 : 621.385.8

**5039. Electron beams in axially symmetrical elect and magnetic fields.** C. C. WANG. *Proc. Inst. Rad Engrs*, **38**, 135–47 (*Feb.*, 1950).

Considers the formulation of the equations gover ing the motion of an electron beam in axia symmetrical magnetic and electric fields. T equations are obtained for the trajectories of t electrons along the outer edge of the beam for t most general case, in which there are both axial a radial components of the fields. It is shown that, a result of symmetry, the combined effects of t electric and the magnetic fields can be expressed as single generalized potential function which depen only on the axial and radial space co-ordinate This enables the axial and radial force componer to be expressed as the axial and radial components the gradient of this potential function. Numeric solutions have been obtained by numerical integratio for the trajectories in a uniform magnetic fiel Curves are presented in normalized form, giving th results of these solutions for practical cases. It shown that there exists an equilibrium radius f which the net radial forces acting on the electrons zero, and that the outer radius of the beam w oscillate about this equilibrium value, the amplitu being non-symmetrical and depending upon th initial conditions, and the wavelength (distan between successive maxima) depending upon th amplitude.

537.533.72 : 621.385.83

**5040. Synthetic representation of the properties of family of electrostatic lenses and mirrors.** E. REGE STREIF. *C.R. Acad. Sci., Paris*, **230**, 734–5 (*Feb.* 2 1950) *In French.*

A theoretical study of the isolated 3-electrode len The equation for the Gaussian trajectory is deduce from a synthetic expression for the axial potentia and by a change of variable is transformed into a equation which is soluble in terms of generalize hypergeometric series. The dimensions of the len appear as a parameter, the system being a lens fo values of the parameter $> 1$ and a mirror fo values $< 1$. A. H. W. BEC

537.533.72 : 621.385.83

**5041. On the electrostatic lens.** H. BRUCK AN P. GRIVET. *Rev. Opt.* (*Théor. Instrum.*) **29**, 164–7 (*March*, 1950) *In French.*

The lens was studied by measuring the axial fiel in an inclined trough. The lens properties wer found as a function of the diameter of the central hol and the thickness of the centre electrode. Th resolution is discussed and a qualitative descriptio of the effects of eccentricity of the central hole given A. H. W. BEC

537.533.72 : 621.385.833 : 621.317.729

**42. Construction of an electrolytic trough and its e in the calculation of electrostatic lenses.** A. ERTAUD. *v. Opt. (Théor. Instrum.)* **29,** 171–80 (*March,* 1950) *French.*

A general discussion of the experimental difficulties countered in the use of the electrolytic trough and ethods for overcoming them. A novel technique is entioned. This is to measure the potential along a nerator of the cylinder whose base is the smallest le of the electron lens studied. This distribution is presented by a series of Legendre polynomials and us the exact determination of the axial potential stribution is possible. This is very useful especially hen inclined troughs are used since the direct termination of the axial potential is then subject considerable error. A brief discussion of trajectory otting techniques is included. A. H. W. BECK

537.533.73 : 548.74

**43. On the theory of Kikuchi bands.** E. FUES ND H. RIEDEL. *Ann. Phys., Lpz.,* **6,** 105–9 (1949) *German.*

The theories of Artmann [Abstr. 135 (1948)] and iedel [*Diss., Stuttgart* (1949)] are compared; the rmer is valid for very deep potential troughs in the ystal, the latter for shallow. The predicted intensity stribution across the band depends on the form of e trough; experiments on the 060 band of muscovite ow that it falls within the range of validity of iedel's theory. A. J. C. WILSON

537.533.73 : 548.74

**44. On the explanation of the Kossel–Möllenstedt ectron interferences of convergent beams on thin ils. II.** E. FUES. *Z. Phys.,* **125** (*No.* 7–10) 531–8 949) *In German.*

Supplements the earlier theoretical explanation Abstr. 600 (1949)] with the results of a comprehensive calculation, the details of which will be mmunicated later. The band displacement is plained with the aid of a mechanical analogy. he explanation permits of an experimental deterination of the phase factors of the structure mplitude. H. G. SOLOMON

537.533.74

**45. Multiple scattering of fast electrons. I. heoretical considerations.** K. SHINOHARA. *J. Phys. oc. Japan,* **4** (*No.* 3) 144–8 (*March–April,* 1949).

The multiple scattering of fast electrons by thin ils has been calculated on the assumption that the ectrons are diffracted by minute crystals forming the il. The method used was that of Williams and the sulting distribution of the projected angles is given. he result shows a better agreement with most of the xperiments than the previous theories. A.

537.533.74

**46. Multiple scattering of fast electrons. II. Comarison with experiments.** K. SHINOHARA, K. INOUE ND N. HIROHATA. *J. Phys. Soc. Japan.,* **4,** 227–9 *July–Dec.,* 1949).

A cloud chamber measurement was made of the attering of electrons of kinetic energy between 1·5 nd 5·8 MeV by a Pb foil of thickness 0·115 mm. he result was in an approximate agreement with the sult of a similar measurement made by Sheppard and Fowler. This result as well as the results by various other authors was compared with the theory of Williams and also with the theory given in the previous paper [Abstr. 5045 (1950)]. It is shown that the latter is, generally, in a better agreement. A

537.534

**47. Ion discrimination in mass spectrographs.** G. CARERI AND G. NENCINI. *Nuovo Cim.,* 7, 64–8 (*Jan.,* 1950) *In Italian.*

It is shown that it is impossible to calibrate a mass-spectrograph for intensity measurements if one selects the masses only by varying the electric field. The results obtained depend then upon the pressure and also on the first accelerating potential. This is not the case if magnetic instead of electric scanning is employed. L. PINCHERLE

537.534

**48. A new type mass spectrometer.** L. KERWIN. *Rev. Sci. Instrum.,* **21,** 96–7 (*Jan.,* 1950).

537.534 : 621.384.6

**49. The cyclosynchrotron.** M. L. OLIPHANT. *Nature, Lond.,* **165,** 466–8 (*March* 25, 1950).

A machine is proposed for the acceleration of atomic particles to energies of 2 or $3\times10^9$ eV. A frequency-modulated cyclotron is to produce particles of 200 MeV travelling on an orbit of 150 cm radius in a magnetic field of 15 000 gauss in a conventional steel yoke magnet. These particles are injected into a concentric air-cored coil in the magnet gap, in which an annular pulsed field of 65 000 gauss is produced. During the rise of this field the accelerating frequency is increased to give synchrotron acceleration. The pulse of current is to be drawn from a homopolar generator in subsidiary gaps of the main magnet, producing $10^6$ A peak current in a rise time of 0·1 sec and at 500 V. A first model is under construction. W. I. B. SMITH

537.534.74

**50. Study of the multiple scattering of fast charged particles in a gas and its role in the interpretation of cloud-chamber tracks.** G. GROETZINGER, M. J. BERGER AND F. L. RIBE. *Phys. Rev.,* **77,** 584–94 (*March* 1, 1950).

The curvature of the track of a fast charged particle in a magnetic cloud chamber varies along the track because of the multiple scattering of the particle by the gas in the chamber. By measurement of the mean and the fluctuations of the curvature, it is possible (1) to determine the multiple scattering in a gas of a particle of known mass, and (2) to estimate, on the basis of a verified multiple scattering law, the mass and energy of a particle. The statistical uncertainty inherent in such estimates is discussed. The multiple scattering of 132 $\beta$-particles, ranging in energy from 50 to 1 700 keV, with a total path length of 1 800 cm in 1 atmos. of A, was measured and compared with the predictions of theories. A.

537.534.74 : 539.174

**51. The inelastic scattering of protons by magnesium, aluminium and other light elements.** E. H. RHODERICK. *Proc. Roy. Soc. A,* **201,** 348–65 (*April* 26, 1950).

The energy spectrum of 4·5 MeV protons scattered by some light elements was determined by using a

proportional counter in conjunction with absorbing foils. Mg gave groups attributed to levels at $1{\cdot}36 \pm 0{\cdot}03$ and $1{\cdot}82 \pm 0{\cdot}04$ MeV respectively above the ground state, the former being almost certainly associated with $Mg^{24}$. The angular distribution and excitation function of this group were examined in some detail. The proton groups from Al corresponded to levels at about 1 and $2{\cdot}15 \pm 0{\cdot}05$ MeV respectively above the ground state. The lower level has a complex structure and probably consists of two levels at about $0{\cdot}80$ and $0{\cdot}97 \pm 0{\cdot}02$ MeV, the amplitudes of the corresponding proton groups showing a marked angular dependence. No inelastically scattered protons were observed from C, O or Cu, while Be gave a group consistent with the existence of a metastable state in $Be^9$ at $2{\cdot}39 \pm 0{\cdot}05$ MeV above the ground state. A short theoretical discussion of the mechanism of the process is given which suggests that inelastic scattering is predominantly a $(p, p)$ process involving formation of a compound nucleus. A.

537.534.75 : 539.164

**The range-energy curves for protons and alpha-particles.** *See Abstr.* 5225–6

## DISCHARGE TUBES . COUNTERS 537.54

537.542

**5052. On the velocity of discharge propagation in externally quenched Geiger counters.** C. Balakrishnan and J. D. Craggs. *Proc. Phys. Soc., Lond. A*, **63**, 358–66 (*April*, 1950).

A new method for measuring the propagation velocity of the discharge along a Geiger non-proportional counter is described. The results obtained with cylinder grade A, H and Ne are summarized graphically, and a brief discussion of propagation mechanisms is given. A.

537.542

**5053. On the efficiency of quenching and anisotropy in proportional counters.** S. Akpinar. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **13**, 165–85 (*July*, 1948) *In German.*

A comprehensive paper on some aspects of proportional counters. Air and alcohol fillings were studied and amplification factors up to $1{\cdot}1 \times 10^4$ (for $\alpha$-rays travelling axially) or up to $2 \times 10^3$ (for $\alpha$-rays travelling radially) were used. A study of the statistical variations in pulse size as a function of counter voltage, etc., was made in detail for air and alcohol fillings. Certain anomalous variations, with tube voltage, of the amplification factor are described and discussed.

J. D. CRAGGS

537.542

**5054. On the spread of the discharge in proportional counters.** R. Akpinar. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **14**, 281–310 (*Oct.*, 1949) *In German.*

A very detailed paper dealing with problems relating to the extent of discharge spreading, as a function of various parameters, in tube counters (proportional and non-proportional). Divided cathode counters of various types were used, and the effect of varying the tube voltage from the proportional to the non-proportional regimes is discussed in detail for various methods of irradiation. The circumferential spread of the discharge round the wire in proportional counters is discussed.

J. D. CRAGGS

537.542 : 539.16.08

**5055. Counting tubes: theory and applications.** S. C. Curran and J. D. Craggs. *London, Butterworth's Scientific Publications; New York, Academic Press* (1949) 328 *pp.*

Contains chapters on: kinetic theory of discharges and ionization, ionization chambers and proportional counters, internally quenched counters, externally quenched counters, counter efficiencies and the analysis of data, the construction of counting tubes, counter circuits, etc., nuclear applications of counters, the use of counters in cosmic-ray studies and in more general applications, and on special forms of counters (e.g. scintillation counters, spark counters, etc.). Special emphasis is given to proportional counters and to an account of modern circuit developments; coincidence counting is also discussed at length in various parts of the book (for cosmic-ray studies and for measurement of counter efficiencies, etc.). The miscellaneous counter applications that are mentioned include the inspection of castings and metal specimens, geological prospecting, work with soft X-rays and with radioactive tracers. There are 119 figures and the bibliographies in the 12 chapters give 480 references. J. D. CRAGGS

537.542 : 539.16.08

**5056. The behavior of rectangular and square section transparent beta-counters.** L. M. Silver and J. B. Warren. *Rev. Sci. Instrum.*, **21**, 95–6 (*Jan.*, 1950).

537.542 : 539.165

**5057. Gas phase counting of low energy beta-emitters.** W. Bernstein and R. Ballentine. *Rev. Sci. Instrum.*, **21**, 158–62 (*Feb.*, 1950).

A proportional counter has been designed to detect soft $\beta$-emitters in the gas phase. Data is presented to illustrate the applicability of the counters to the detection of $C^{14}$, $S^{35}$ and $H^3$. Various partial pressures of $C^{14}O_2$ have been investigated to determine the effects on the counter properties. Corrections have been made for the counter ends and the memory effects are described. An energy spectrum is presented for $H^3$ to determine the low energy limit of the instrument. A.

537.542

**5058. Conductivity pulses induced in insulating liquids by ionizing radiations.** N. Davidson and A. E. Larsh, Jr. *Phys. Rev.*, **77**, 706–11 (*March* 1, 1950).

Conductivity pulses due to electron collection have been observed in liquid and solid A exposed to $\alpha$- or $\gamma$-radiation. The maximum pulse sizes, $P_M$, for $\alpha$-particles depend only on the field strength, $E$, and not on the electrode spacing, proving that the pulse limiting effect is columnar recombination and not electron trapping by impurities. The maximum pulse sizes obey the equation $(P_M/P_0) = 1 - \exp(-AE)^{\frac{1}{2}}$, where $P_0$ is the $\alpha$-pulse size in an A gas counter. The counting efficiency for

particles is close to 100%, but there is some variation in pulse size due to variation of columnar combination with angle of emission. No α- or pulses were observed in liquid N or heptane, but weak α-induced pulses were observed in liquid ethane. The effects of N and O in solution in liquid A in decreasing the pulse sizes are interpreted as being due to electron capture by these molecules. A.

537.542 : 535.376

**Temperature variation of decay times of scintillation phosphors.** *See Abstr.* 4871

537.542 : 537.312.5

**Multiplication effect of cadmium sulphide crystals due to alpha particles, electrons and gamma rays.** *See Abstr.* 4991

537.542 : 537.37

**Excitation of luminescence in cadmium sulphide crystals by α-particles and electrons.** *See Abstr.* 4858

537.542 : 621.385.15 : 621.318.572 : 621.383

**5059. Photomultipliers for scintillation counting.** J. A. MORTON. *RCA Rev.*, **10**, 525–52 (*Dec.*, 1949).

Describes photomultipliers made for scintillation counting and evaluates the importance of various operating parameters. Four R.C.A. and three E.M.I. tubes are discussed in detail. All have $Cs_3Sb$ photocathodes, with max. sensitivity at 4 000–4 800 Å where the quantum efficiency may be as high as 30%. The thermionic emission $\simeq 10^3$ electrons/cm² at 0°K and doubles for each 10°K rise. The Ag–CsO–Cs surface has lower quantum efficiency and higher thermionic emission and is therefore not used. The multiplier gain should be $> 3\times10^5$. 9, 10 or 11 stages are used with $\delta$ from 4–6. Statistical questions introduced by the fact that the value of $\delta$ is subject to a probability distribution are discussed as is the resolving time. Suitable circuit design is discussed.

A. H. W. BECK (R)

537.542 : 539.166

**5060. A sensitive directional gamma-ray detector.** B. CASSEN, L. CURTIS AND C. W. REED. *Nucleonics*, **6**, 78–81 (*Feb.*, 1950).

γ-rays are detected by a Ca tungstate crystal and photomultiplier enclosed in a Pb housing, through which the radiation may pass by way of a narrow channel. A counting efficiency of 25·8% was obtained with the 0·37 MeV γ-rays from $I^{131}$, but the 80 keV radiation from the same isotope could not be detected above the multiplier noise. L. R. SHEPHERD

537.542 : 539.164

**5061. Quantitative measurements on alpha particles with scintillation counters.** I. BROSER AND H. KALLMANN. *Ann. Phys., Lpz.* (*Folge* 6) **4** (*No.* 1–2) 61–8 (1948) *In German.*

Layers of powder-form ZnS–Ag phosphors can be used with photomultipliers to measure α-particle energies and to calibrate source strengths. Particles of the same energy give rise to distribution in size of output pulses about a mean value. The spread is decreased by use of single crystals of CdS (half-width ± 25% of mean pulse size). Conversion efficiencies are smallest for 0·1–0·5 MeV particles but 100 α/sec can be easily detected as a mean current of $10^{-9}$ A output from the counter. G. F. J. GARLICK

537.542

**5062. Scintillation-type ion detector.** P. I. RICHARDS AND E. E. HAYS. *Rev. Sci. Instrum.*, **21**, 99–100 (*Jan.*, 1950).

537.542

**5063. On the new technique of scintillation counters. II.** M. AGENO, M. CHIOZZOTTO AND R. QUERZOLI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **6**, 626–31 (*May*, 1949) *In Italian.*

Owing to the difficulty of obtaining fluorescent crystals of large dimensions, a systematic search was made for liquids and solutions which should fluoresce by α-, β- or γ-excitation. The fluorescence of pure liquids was found generally to be too small; while promising results are being obtained with some solutions. The activity was found to increase monotonically with concentration, showing that Perrin's law is not obeyed. This may be explained by the formation of fluorescent centres. L. PINCHERLE

537.542 : 621.318.572

**5064. Neon diode ring counter.** J. C. MANLEY AND E. F. BUCKLEY. *Electronics*, **23**, 84–7 (*Jan.*, 1950).

This inexpensive counter can count up to rates of 500 impulses/sec. It consists of a chain of similar networks, each made up of a 0·04 or 0·25 W Ne tubes, a Ge crystal diode and a resistor in series, to form shunt arms, with capacitive coupling from one arm to the next. The whole chain is fed from a d.c. supply through a resistance to give a terminal voltage slightly < than the neon striking voltage. An incoming pulse lowers, either mechanically through switch operation or by some other device, the d.c. voltage and causes whichever Ne tube is operating to be extinguished. The voltage across the associated resistor falls to zero and the associated capacitor, slowly discharging in an inverse direction through the diode, raises the potential across the next Ne tube above its striking voltage, causing it to fire. The action advances one stage further down the chain for each count, with one Ne tube only operating at a time, and so 10 such shunt arms, with the 10th coupled back to the 1st, constitute a ring-of-10 counter. Three such units can, of course, be cascaded to form a 3-decade counter. By changing the connections of the capacitors, the additive action is altered to one of subtraction. Electronic triggering can be effected by applying an externally-derived pulse either to another similar network containing a Ne tube or, if the pulse rate is > 150/sec, to a thyratron. A predetermining circuit, to produce a signal when a desired count has been reached, can be provided by similar Ne tubes, 10-way switches and sensitive relays. H. G. M. SPRATT (R)

537.542 : 621.315.59 : 621.318.572

**5065. Counter circuits using transistors.** E. EBERHARD, R. O. ENDRES AND R. P. MOORE. *RCA Rev.*, **10**, 459–76 (*Dec.*, 1949).

Several transistor multivibrator circuits are described which perform the function of a decade counter composed of "bistable" stages or those of a frequency divider. It is shown how the characteristics of a single bistable circuit can be calculated from the commonly known transistor constants. Two de-

monstration units are discussed in some detail and some of the characteristic waveforms are given. Counter operation at 1 Mc/s and more is possible. The temperature dependence of transistors and the variation of characteristics from one unit to another at present prevent the large-scale application of crystal triodes for counter circuits. H. K. HENISCH (R)

537.542

**5066. On trebly chance coincidences.** G. LOVERA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **1,** 964–9 (*Sept.*, 1946) *In Italian.*

The number of trebly chance coincidences in a Geiger–Müller counter mounting may disagree with the results of Schiff theory if the pulses are very short, and if the probability of recording a chance coincidence depends on the time during which the pulses are superposed. G. RIGHINI

537.542

**5067. Fluctuations in proportional counters.** W. F. G. SWANN. *J. Franklin Inst.*, **249,** 133–8 (*Feb.*, 1950).

It is shown that a large proportion of the ions produced by a cosmic ray in a counter arise from a comparatively small proportion of primary events. This may account for the large fluctuation observed between pulses. N. L. JOHNSON

537.542 : 621.318.57

**5068. Wire recorded magnetic pulse timing circuit.** C. R. EMIGH. *Rev. Sci. Instrum.*, **21,** 142–4 (*Feb.*, 1950).

A time delay circuit is described for timing and sequencing the operations of a cloud chamber. By magnetizing a moving section of recording wire and at a later time using the magnetized section to actuate a sensitive relay, delays from 0·01 to 0·25 sec are obtained. The delay can be adjusted visually to an accuracy of 0·001 sec. A.

## IONIZATION . THERMIONICS 537.56/.58

537.561

**5069. The determination of the ionization energy from current-strength measurements in gases.** H. V. BROTHERUS. *Ann. Acad. Sci. Fennicae, Ser. A*1, *Paper* 19, 6 *pp.* (1943) *In German.*

A short note discussing results of measurement of saturation current due to Saha thermal ionization in a gas at temperature $\simeq$ 700°K.

F. LLEWELLYN JONES

537.561 : 535.325

**5070. Dispersion formula and characteristic oscillations of an ionized gas.** G. BURKHARDT. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 6–8) 373–80 (1950) *In German.*

The theory of a plasma can be obtained from the Lorentz dispersion theory of a neutral gas by equating the characteristic frequency of the polarization electron to a known boundary frequency (regarded as characteristic of the oscillating plasma), the Lorentz polarization term then vanishes on the dispersion formula for the plasma. F. LLEWELLYN JONES

537.56

**5071. Conductivity of ionized air at high frequencies.** A. SZÉKELY. *S.B. Öst. Akad. Wiss., Abt. IIa,* **157,** 125–42 (*No.* 1–5) (1949) *In German.*

The electrical conductivity and dielectric constant of a plasma in air at 0·1 mm Hg was measured at 3–5 Mc/s. The short relaxation times observed were discussed in relation to the effect of strong, alternating plasma micro-fields as opposing orientation of negative-ion dipoles. F. LLEWELLYN JONES

537.562 : 521.038

**5072. Dynamics of plasmas. I. Fundamental equations of a plasma in crossed fields.** A. SCHLÜTER. *Z. Naturforsch.*, **5a,** 72–8 (*Feb.*, 1950) *In German.*

Equations of motion and of diffusion are set up taking into account "frictional" forces and electromagnetic interaction. The basic equations are applied to the case of crossed electric and magnetic fields: it is concluded that in a plasma the conceptions of a Hall effect, and of the decrease of conductivity due to a magnetic field, have no meaning. Application to astrophysics is indicated.

F. LLEWELLYN JONES

537.565

**5073. Drift velocities of electrons in argon, nitrogen, and argon–nitrogen mixtures.** E. D. KLEMA AND J. S. ALLEN. *Phys. Rev.*, **77,** 661–5 (*March* 1, 1950).

The drift velocities of electrons produced by Po α-particles in a parallel-plate ionization chamber have been measured for pure A, pure N and A–N mixtures. The A data agree with the results of other investigators using the same method, but disagree with those obtained from the pulsed X-ray method. The N data agree with the results published by early investigators. A.

538.566 : 535.422 : 621.396.677

**5074. Diffraction of a spherical electro-magnetic wave by a paraboloid of finite dimensions, the exciting dipole being situated on the axis of symmetry of the paraboloid.** R. G. MIRIMANOV. *Dokl. Akad. Nauk, SSSR,* **67** (*No.* 5) 835–8 (1950) *In Russian.*

537.568

**5075. Electron recombination in helium.** D. R. BATES. Letter in *Phys. Rev.*, **77,** 718–19 (*March* 1, 1950).

Considers the value found experimentally by Biondi and Brown [Abstr. 4815 (1950)] for the electron recombination coefficient in He. Discussion of various possible recombination mechanisms indicates that the ions involved in these expts. were $He_2^+$ rather than $He^+$. F. LLEWELLYN JONES

537.58 : 537.312.5 : 535.215

**5076. Effect of the type of support on the photoelectric work function of silver films.** L. L. BLACKMER AND H. E. FARNSWORTH. *Phys. Rev.*, 77, 826–9 (*March* 15, 1950).

Ag was doubly and fractionally distilled with the middle fraction deposited on previously outgassed bulk Ag, on smooth fused quartz, and on outgassed Mo sheet in a sealed-off, gettered tube. Photoelectric measurements were made using the Fowler method. Deposit of a film of Ag on bulk Ag caused

decrease by varying amounts as great as 0·25 eV 0·50 ± 0·02 eV. Subsequent heating estimated below 100°C caused $\phi$ to increase to the original e. $\phi$ for an Ag film on smooth fused quartz and outgassed Mo sheet is 4·41 eV. The results are affected by residual gas pressure in the tube. The values of $\phi$ for the film appear to be due to a face structure composed of microcrystals which much smaller than those of the bulk Ag. The ations in the observed values of $\phi$ for films on erent supports is attributed to a dependence of sizes of the microcrystals on the structure of the port. Information is given regarding the effect of equilibrium conditions between volume and face gas on the value of $\phi$ during the outgassing iod of bulk Ag. A.

537.583 : 621.315.592.4 : 621.385.1.032.216

**7. The conduction mechanism of oxide-coated hodes.** R. Loosjes and H. J. Vink. *Philips Res. ?.*, **4**, 449–75 (*Dec.*, 1949).

Measurements on the conductivity of oxide cathodes re extended to very low temperatures, ~ 500°K. was found that the $\log \sigma$ *v.* $T^{-1}$ curve has a knee ~ 800°K, the activation energy for $T < 800$°K ng 5–10 times smaller than above 800°K. In some itances a further knee is observed at ~ 1 000°K. e form of the curve is attributed to two exponential nductivities in parallel and the hypothesis is put ward that the conductivity with small activation ergy is due to impurity centres, while that with ge $\Delta E$ is due to conduction through the electron s filling the pores of the material. The theoretical nsequences are examined and it is shown *I*, *V* curves r the current across the coating show the general haviour expected as a result of this hypothesis. A ief reply is made to the objection of Hannay *et al.* bstr. 273 (1950)] who found that operation in atm. of He did not alter the conductivity. It is inted out that the m.f.p. of $10^{-4}$ cm was of the me order as the pore size, so that present results not yet permit a definite choice of model.

A. H. W. Beck (R)

## COSMIC RAYS 537.591

537.591

**078. The origin of cosmic rays.** Ya. P. Terletskiĭ. *Exp. Theor. Phys., USSR*, **19**, 1059–75 (*Dec.*, 1949) *Russian.*

Theoretical. The dynamics of charged particles oving in magnetic fields are developed. It is shown at the cosmic magnetic fields result in electric fields f sufficient strength to produce the primary cosmic ays. Stellar and galactic magnetic fields are dis-ussed in detail, and the results related to recent bservations on the heavy nuclei in the primary omponent, using photographic plates.

E. P. George

537.591 : 523.854

**On the origin of the cosmic ray-radiation in the Milky Way.** *See Abstr.* 4657

537.591.1

**5079. The present status of the evidence for the atom-annihilation hypothesis.** R. A. Millikan. *Rev. Mod. Phys.*, **21**, 1–13 (*Jan.*, 1949).

The results of balloon flights, in particular in the neighbourhood of the geomagnetic equator in India and Mexico, are considered still to be favourable to the assumption that cosmic-ray primaries are of discrete energies arising from the total annihilation of the abundant elements of interstellar matter.

J. G. Wilson

537.591.15

**5080. On the second maximum in cosmic ray shower curves.** M. Della Corte. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **1**, 974–82 (*Sept.*, 1946) *In Italian.*

The coincidences produced by showers with 2, 3, 4, 5 particles are simultaneously recorded with a set of 9 Geiger–Müller counters under variable thickness of lead. The coherence effect is evaluated from Arley's theory and Rossi curves obtained for showers with 2 and 3 particles. A second maximum is found in the transition curve for 2 particle showers but not in that for 3 particle showers. G. Righini

537.591.15

**5081. The influence of experimental conditions on some measurements of showers produced by photons.** M. Della Corte. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **2**, 311–14 (*March*, 1947) *In Italian.*

Disagreement between experimental results and Arley's theoretical curves is explained, taking into account that the probability of recording showers with small number of particles is low G. Righini

537.591.15

**5082. On the applicability of the Poisson distribution to the spatial distribution of particles, and concerning the density spectrum of wide atmospheric showers.** M. I. Podgoretskiĭ, I. L. Rozental and S. A. Slavatinskiĭ. *J. Exp. Theor. Phys., USSR*, **19**, 1141–6 (*Dec.*, 1949) *In Russian.*

Air showers were studied using 3 large trays of counters and 20 single counters. The single counters were hodoscoped, coincidences in the large trays providing the master pulses. The distribution of events in the single counters were found to be consistent with a Poisson distribution. The frequency of discharge of groups of single counters were not found to be consistent with the usual power-law expression for the density spectrum, and modifications to the latter are discussed. E. P. George

537.591.15

**5083. On the production of penetrating showers in nuclear collisions.** K. Sitte. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 295–6 (*March*, 1950).

The intensity of particles producing penetrating showers, if extrapolated to the top of the atmosphere, is only about $\frac{1}{10}$ of the primary flux. This result is in accord with the form of energy loss assumed by Heitler and Janossy [Abstr. 4162 (1949)] which favours small fractional transfers at all energies, with the exponential absorption of shower producing particles with an absorption range ~ 2× the collision

range, and with the observed absence of latitude effect (at sea level) of penetrating showers. J. G. WILSON

537.591.15

**5084. A study of penetrating showers at 3 260 meters.** W. D. WALKER. *Phys. Rev.*, **77**, 686–98 (*March* 1, 1950).

A series of experiments on local penetrating showers is described. Neon bulbs electronically connected to Geiger counters were lighted and photographed when those counters were struck in a simple coincidence. One row of counters recorded delayed coincidences. Most of the experiments described were performed at Echo Lake, Colorado, elevation 3 250 m. The experiments indicate that there are approximately equal numbers of charged and neutral primary particles. The measured mean free path is found to decrease with increasing energy. The charged primary particles are shown to have a very strong zenith angle dependence. Properties of the secondary particles of the showers were also studied. A large fraction of the penetrating particles locally produced are shown to be mesons. Of all the mesons that stop and decay in the apparatus, apparently about 16% are locally produced in penetrating showers. There are many short-range particles produced that are not mesons. The angular distribution of the penetrating secondaries about the shower axis shows a strong concentration of the particles in the forward direction, such that they could not be emitted symmetrically in the centre of gravity system. A.

537.591.15

**5085. The lateral distribution of protons in extensive air showers.** G. MOLIÈRE. Letter in *Phys. Rev.*, **77**, 715–16 (*March* 1, 1950).

537.591.3

**5086. The absorption curve of the primary cosmic-ray particles.** G. T. ZATSEPIN. *J. Exp. Theor. Phys., USSR*, **19**, 1104–7 (*Dec.*, 1949) *In Russian.*

Theoretical. Assuming a power-law primary energy spectrum, the absorption curve in the atmosphere is calculated, including charge-exchange effects. E. P. GEORGE

537.591.3

**5087. Atmospheric absorption of the star-producing component of cosmic rays.** M. JANNOT AND P. ALLENO-RAGOUGNOT. *J. Phys. Radium*, **11**, 102–4 (*Feb.*, 1950) *In French.*

Ilford $B_2 + B$ plates were exposed at altitudes 3 469 m and 1 257 m at close sites. The absorption of stars of 3 or more prongs corresponded to a range $154 \cdot 5^{+27}_{-17}$ gm cm$^{-2}$ in air, and there was no significant difference in the size distribution of stars at the two altitudes. An event is also indicated in which a large star is accompanied over an area $\sim 0 \cdot 3$ mm$^2$ by many tracks of complex orientation. J. G. WILSON

537.591.5

**5088. The variation of intensity of cosmic-ray neutrons in the atmosphere.** E. BAGGE AND K. FINCKE. *Ann. Phys., Lpz.*, **6**, 321–37 (1949) *In German.*

An analytic solution is obtained for the density distribution of neutrons for energies from several MeV to thermal. In agreement with experime observations, the theoretical neutron intensity pa through a maximum at a height of 20–22 km. neutron energies from thermal up to 1 kV the tribution is given approximately by $dE.E^{-1 \cdot 29}$. available Cd and B absorption data may be explai in terms of this spectrum. E. P. GEOI

537.59

**5089. On the influence of solar activity on intensity of cosmic rays.** I. L. CHAKRABORTY A S. D. CHATTERJEE. *Indian J. Phys.*, **23**, 525–34 (*De* 1949).

A report of a sudden increase in cosmic-ray tensity following the solar flare on January 25, 19 is given. It is accompanied by a rapid diminution cosmic-ray intensity and a slow recovery as a result the concomitant magnetic storm. The relationship the two processes with solar activity is discussed.

537.59

**5090. The semi-diurnal component of cosmic r intensity at Bandung (Java).** H. R. WOLTJER AN GO POK OEN. *Physica*, **16**, 122–32 (*Feb.*, 1950).

Observations by means of a Steinke ionizatio apparatus during 1939 and 1940 show a semi-diurn component in opposite phase to the semi-diurn component of the barometer. On closer inspection may be interpreted as a superposition of a norm barometer effect (opposite phase) and a same pha component that can be explained as a result of th semi-diurnal movement of the meson-producin layer in the atmosphere (theory of Pekeris; Nicolso and Sarabhai). It thus appears to confirm the resul of Rau and Regener concerning cosmic-ray intensiti fluctuations under 40 m water in Lake Constanc [*Naturwiss.*, **27**, 803 (1939)].

537.591.

**5091. The zenith angle variation of the latitude effec of cosmic rays.** H. D. RATHGEBER. Letter in *Phys Rev.*, **77**, 566–7 (*Feb.* 15, 1950).

537.591.

**5092. The zenith angle dependence of the cosmi radiation above the atmosphere at $\lambda = 41°$N.** S. F SINGER. Letter in *Phys. Rev.*, **77**, 729–30 (*March* 1 1950).

537.591.

**5093. On the nature of the cosmic radiation near the Pfotzer maximum at $\lambda = 41°$N.** S. F. SINGER. Letter in *Phys. Rev.*, **77**, 730 (*March* 1, 1950).

537.591.5

**5094. The increase in the primary cosmic-ray intensity at high latitudes, and the non-existence of a detectable permanent solar magnetic field.** M. A. POMERANTZ. *Phys. Rev.*, **77**, 830–7 (*March* 15, 1950).

The primary cosmic-ray intensity at Churchill, Manitoba (geomagnetic latitude 69° *N*) has been compared directly with that at Swarthmore, Pennsylvania (geomagnetic latitude 52° *N*). The measurements, obtained with identical vertical quadruple-coincidence counter trains, have revealed an increase at the more northern station caused by the presence in the primary radiation of particles having energies below that which would have been permitted had the sun's magnetic field been effective to the extent previously assumed. The ratio of intensities is

, 69°)/$I_T$(0, 52°) = 1·46. Intensity *v.* altitude es were obtained with several different thicknesses bsorber interposed in the counter trains. These eriments have revealed the absence of a sharp off at the low energy end of the spectrum, imposed a permanent solar dipole-moment having a gnitude consistent with certain controversial ophysical determinations. Such a dipole-moment ld have produced a knee in the latitude effect at ut 50° *N* geomagnetic latitude. Furthermore, e is no indication of any diurnal variation which ld be in conformity with the existence of a per- nent dipole-moment at the sun. The differential rgy distribution at the low energy end of the nary cosmic-ray spectrum cannot be evaluated ctly because of absorption considerations, but it is btful that the exponent in an inverse power-law resentation is as large as has usually been assumed etofore. Alternative explanations of the observed ease in counting rates, by invoking trapped orbit e-entrant particle hypotheses, have been considered l rejected. It is concluded that the sun possesses detectable permanent magnetic field and, on the is of the present experiments, an upper limit of $\times 10^{33}$ gauss-cm$^3$, as compared with the previously ted value of $10^{34}$ gauss-cm$^3$, may be assigned as a ximum possible value of the dipole-moment, if eed it exists at all. A.

537.591.5 : 523.7

**5. Cosmic rays and the magnetic field of the sun.** W. N. Dolbear and H. Elliot. Letter in *Nature*, *id.*, **165**, 353–4 (*March* 4, 1950).

Using a 3-fold counter telescope, the difference ween the day and night intensities of cosmic rays 30 000 ft was found to be $-0{\cdot}12 \pm 0{\cdot}83\%$. king the value of the solar magnetic moment posed to explain the knee in the latitude curve, expected value lies in the range $+1{\cdot}9$ to $+3{\cdot}5\%$. e existence of a solar magnetic field sufficient to count for the latitude cut-off at 50° is doubted. E. P. GEORGE

537.591.8

**6. Observations of the production of meson pairs.** P. Zhdanov and P. I. Lukirskiĭ. *Dokl. Akad. uk, SSSR*, **69** (*No.* 6) 785–6 (1949) *In Russian.*

Grain counts performed on two single tracks show minimum of grain density in the middle. These are ought to be examples of the producton of $\mu$-meson irs by neutral mesons of mass $\sim 416\, m_e$. E. P. GEORGE

537.591.8

**97. On the nuclear stars.** Y. Fujimoto and Yamaguchi. *Progr. Theor. Phys.*, **4**, 468–76 *ct.–Dec.*, 1949).

The evaporation theory of Weisskopf is extended considering the cooling of the nucleus during the aporation process. Fluctuations are considered. e energy-loss in nuclei of energetic incident particles calculated, and the theory applied to many energetic integrations studied experimentally. The agree- nt between theory and observation is fair. E. P. GEORGE

537.591.8

**5098. On the nuclear stars (addendum).** Y. Yamaguchi. Letter in *Progr. Theor. Phys.*, **4**, 569 (*Oct.–Dec.*, 1949).

The assumption that the fluctuations follow a Poisson distribution, made in the previous abstract, is justified. E. P. GEORGE

537.591.8

**5099. Nuclear disintegrations and electronuclear showers in cosmic rays.** A. N Gorbunov *J. Exp. Theor. Phys., USSR*, **19**, 1076–97 (*Dec.*, 1949) *In Russian.*

Two proportional counters shared a common wall consisting of Al foil. Coincidences between these counters were studied at altitudes of 3 860 and 4 700 m, and were ascribed to nuclear disintegrations. The absorbtion lengths of the radiation producing the coincidences were measured in several materials, and the results, ranging from air, $150 \pm 25$, to Pb, $530 \pm 60$ g/cm$^2$, are discussed in terms of nuclear absorption. Further experiments with the double counter unshielded showed a strong correlation with extensive air showers. Under thick Pb, coincidences between the double counter and additional fast counters were studied, and the results explained in terms of "special" showers. E. P. GEORGE

537.591.8

**5100. The generation of photons by the primary protons of cosmic rays.** E. L. Feinberg. *J. Exp. Theor. Phys., USSR*, **19**, 1098–1103 (*Dec.*, 1949) *In Russian.*

Theoretical. It is shown that the classical formulae for the electromagnetic radiation emitted at the creation (or destruction) of charged particles may, in quantum calculations, be applied up to a frequency $\omega$ such that $\hbar\omega \ll E$, where $E$ is the energy of the particle. Applying this to meson production by primary cosmic rays, it is concluded that the energy of the electromagnetic radiation is approx. $(e^2/\hbar c)E$. The radiation emitted in nucleon scattering with charge exchange is also of the same order. It is concluded that this mechanism is not capable of explaining the observed intensity of the soft component in cosmic rays. Application to the higher energy region of Auger showers looks more hopeful, as the electromagnetic radiation increases logarithmically with energy, and with primaries of $10^{14}$ eV, the frequency of air showers can be understood on these lines. E. P. GEORGE

537.591.8

**5101. The disintegration of boron by cosmic rays.** A. P. Zhdanov and K. I. Ermakova. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 211–14 (1950) *In Russian.*

Colloidal B was introduced into a photographic emulsion, and stars emanating from the colloidal particles were ascribed to B disintegrations. One, described in detail, is alleged to involve 2 slow mesons and is interpreted thus: $\pi^- + {}_5B^{10} \rightarrow {}_1H^1 + {}_2He^4 + \mu^+ + 5n$. Several other B stars are shown, which are interpreted in terms of the capture of neutral mesons. E. P. GEORGE

537.591.8

**5102. Multiple production of mesons.** P. Freier and E. P. Ney. *Phys. Rev.*, **77**, 337–41 (*Feb.* 1, 1950).

Cloud-chamber photographs and photographic emulsion events have been obtained which are interpreted in terms of multiple meson production. In some cases it can be shown by charge conservation and penetration of Pb that a large number of the particles in hard showers are not nucleons or electrons. The results are compared with the predictions of Heisenberg and Leprince-Ringuet. By comparing the interactions in C and Pb one is led to the conclusion that mesons are made at 55° geomag. latitude with an average multiplicity of about 5 by protons of average energy about 8 BeV. A.

537.591.8

**5103. A cloud-chamber study of cosmic-ray nuclear interactions at 3 260 meters elevation.** W. W. Brown and A. S. McKay. *Phys. Rev.*, **77**, 342–54 (*Feb.* 1, 1950).

In 4 949 photographs of cosmic-ray phenomena, not associated with dense air showers, occurring in a counter-controlled cloud chamber surrounded by Pb, the numbers of nuclear interactions in which secondaries were produced and observed to occur in and above the chamber were 182 and 223, respectively. The mean free path for nuclear interaction of the penetrating particles produced in these nuclear interactions is 316 ± 70 g/cm² of Pb, while for nuclear scattering (large angle scattering without the production of secondaries) it is at least 4 or 5 times this value. The projected zenith angular distributions of the secondaries from these interactions are given. The lightly ionizing secondaries going in the forward direction have an angular distribution $\sim \cos^3\theta$, while those in the backward direction from nuclear interactions occurring in the chamber have a uniform distribution. A.

537.591.8

**5104. Mass measurements of fast particles ejected from cosmic ray stars.** J. B. Harding. Letter in *Nature, Lond.*, **165**, 273–4 (*Feb.* 18, 1950).

Particles emitted from nuclear disintegrations with $0{\cdot}25 < \beta < 0{\cdot}43$, observed in Kodak NT4 emulsion exposed at 3 650 m are shown by grain density and scattering measurements to be predominantly protons. These protons cannot be emitted in the evaporation process. J. G. WILSON

537.591.8

**5105. The neutron density in the free atmosphere up to 100 000 feet.** L. C. L. Yuan. Letter in *Phys. Rev.*, **77**, 728–9 (*March* 1, 1950).

537.591.8

**5106. Evidence for a charged heavy meson.** H. H. Forster. Letter in *Phys. Rev.*, **77**, 733–4 (*March* 1, 1950).

A star of 11 tracks was observed in an unstated type of nuclear emulsion flown for several hours at 30 000 ft. One track, ~ 120 $\mu$ in length, is ascribed to an ejected meson which stops in the emulsion without production of a visible secondary particle. Another track, ~ 50 $\mu$ long, is ascribed to a particle travelling towards the star. This particle is assumed to be a heavy meson, and its mass estimated as 700–800 $m_e$. E. P. GEORGE

537.591

**5107. Heavy fragment disintegrations.** P. ] Hodgson. Letter in *Nature, Lond.*, **165**, 355 (*March* 1950).

In Ilford *G*5 plates exposed at the Jungfraujoch 2 stars have been observed showing a close juxta position of tracks. The probability of these occurrin by the overlap of randomly distributed tracks alleged to be very small, and the events are inte preted in terms of the disintegration, at the momen of leaving the parent nucleus, of ejected Li and H nuclei respectively. E. P. GEORG

537.591.8 : 539.1

**5108. On the components responsible for cosmic-ra nuclear disintegrations.** K. H. Höcker and E Schopper. *Ann. Phys., Lpz.*, **6**, 338–52 (1949) *German.*

The observed frequencies of stars cannot b accounted for on the assumption that they ar produced by the protons of the primary componen and their secondary neutrons. The inclusion o neutrettos gives a better representation of the sta frequency and height dependence. The observe predominance of neutral particles in the star-producin radiation, and the change of the star energy distribu tion with height is also accounted for. E. P. GEORG

537.591.8 : 539.17

**5109. Showers of minimum ionizing particles fro cosmic-ray induced nuclear disintegrations in nuclea emulsions.** B. T. Feld, I. L. Lebow and L. S Osborne. Letter in *Phys. Rev.*, **77**, 731–2 (*March* 1 1950).

537.591.8 : 539.18

**5110. Experiments with a Wilson chamber a 3 860 m above sea level.** R. V. Sadovskiĭ, P. A Cherenkov, I. V. Chuvilo and L. S. Zig. *Dokl Akad. Nauk, SSSR*, **69** (*No.* 6) 789–92 (1949) *Russian.*

10 000 photographs were obtained of a randomly expanded horizontal cloud chamber at 3·5 atmos 50 pictures showed ⩾ 2 heavy tracks, the frequency being > that expected from random occurrence. These are ascribed to genetically connected disintegrations. Two tracks showing a high $\delta$-ray frequency consistent with their production by a particle with a charge 4 to 5*e*, are discussed in detail. E. P. GEORGE

537.591.8 : 539.18

**5111. Some decay effects of mesons in penetrating showers observed in a high-pressure Wilson cloud chamber.** G. R. Evans and T. C. Griffith. *Proc. Phys. Soc., Lond. A*, **63**, 296–7 (*March*, 1950).

Two events occurring in a penetrating shower, photographed with counter control in a cloud chamber containing N at 60 atmos., are discussed. The deflection in the gas of a meson ($0{\cdot}5 < \beta < 0{\cdot}7$) track through 23° is interpreted as decay, and since the time of flight of the particle in the chamber ~ $10^{-9}$ sec the meson is probably a $\pi$-meson. The track of a second particle starts in the gas of the chamber: the track is comparable to the other shower tracks and is aligned appropriately in the shower. It is shown to be likely that it is a meson, and a charge exchange interaction of the neutral $\pi^0$-meson is suggested. J. G. WILSON

537.591.8 : 539.18

**2. Further evidence for the existence of τ-mesons.** B. HARDING. Letter in *Phil. Mag.*, **41**, 405–9 *pril*, 1950).

Ilford *G5* emulsions, 200 $\mu$ thick, were exposed der 3 m ice for 85 d at the Jungfraujoch. Two nts are reported which appear to be similar to the neson decay into 3 lighter mesons ($\pi$ or $\mu$) reported Brown *et al.* [Abstr. 1974 (1949)]. E. P. GEORGE

## MAGNETISM 538

538 : 537

**The teaching of magnetism at the college level.** *e Abstr.* 4941–2

538.11

**13. Forces in magnetic media, and the definition magnetic moment.** H. DIESSELHORST. *Ann. Phys.*, z., **3**, 11–30 (1948) *In German.*

A critical discussion of the old problem of the finition of the fundamental magnetic quantities. is shown that: (1) The couple experienced in a ld by a needle-shaped magnet is determined by *H*, th *in vacuo* and in a magnetic medium. The couple perienced by a laminar magnet is determined by *B* any case. Complicated formulae may be obtained th the use of the Maxwell tensor for magnets of her shapes, thereby showing that the definition of agnetic moment on the basis of any particular law arbitrary. (2) The interaction of two needle-shaped agnets is directly ∝ the permeability of the medium; e interaction of two laminar magnets is inversely the permeability. For intermediate cases a compli- ted factor occurs. (3) The Coulomb law for agnetic poles has a meaning only *in vacuo*. (4) *B* is e force vector *in vacuo*, but not in general. For stance, *H* is the force vector in a permanently agnetized deformable medium. L. PINCHERLE

538.114

**14. The internal magnetic field in ferromagnetic aterials.** W. DÖRING. *Z. Naturforsch.*, **4a**, 605–10 *Nov.*, 1949) *In German.*

Shows that Becker and Döring's theory of domain rmation is incomplete if consideration is not given the non-uniform internal magnetic field arising om free poles at the crystal boundaries and from ie internal stresses. In small crystals the magnetic roperties depend primarily on the crystal energy and ie size of the crystallites; in large crystals the internal resses are the predominant factor. Similar con- derations suggest an explanation of the reduction f $\mu$ observed in the frequency range $10^3$–$10^6$ c/s, and lso indicate that $J_{Rem}$ will be $< J_s/2$ as given by ternal stress theory. C. E. WEBB

538.114

**115. The coefficients of the molecular field of mixed ickel and zinc ferrites.** L. NÉEL AND P. BROCHET. *.R. Acad. Sci., Paris*, **230**, 280–2 (*Jan.* 16, 1950) *n French.*

Records variations of $\chi_M$ with temperature above ie Curie point of a series of Ni–Zn ferrites, and educes the values of the constants in the expression $\chi_M = T/C + 1/\chi_0 - \sigma/(T - \theta)$ to give accurate representation of the results. From these constants the coefficients of the molecular field, which characterize a ferrite, are calculated, and it appears that the *AB* and *BB* interactions depend little on the concentration, but the *AA* interaction increases rapidly with the proportion of ZnO, suggesting that the presence of Zn ions in *A* positions greatly increases the negative interaction of Fe ions in these positions through a super-exchange mechanism of type Fe–Zn–Fe. C. E. WEBB

538.114

**5116. Single domain structure in ferromagnetics and magnetic properties of finely dispersed materials.** E. KONDORSKIĬ. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 215–18 (1950) *In Russian.*

The conditions for a small ferromagnetic particle to be a single domain are discussed and the critical size and coercive force of such particles are calculated. The discussion is related to previous work of Stoner and Wohlfarth [Abstr. 1877 (1948), 3259–60 (1947)]. D. SHOENBERG

538.114

**5117. Statistics of the three-dimensional ferromagnet.** D. TER HAAR AND B. MARTIN. Letter in *Phys. Rev.*, **77**, 721–2 (*March* 1, 1950).

538.114 : 539.11

**5118. Statistical theory of the ferromagnetic superlattice. I. General theory.** T. MUTO, T. EGUCHI AND M. SHIBUYA. *J. Phys. Soc. Japan*, **3**, 277–83 (*Sept.–Dec.*, 1948).

By considering order-disorder phenomena on the basis of Bethe's treatment and ferromagnetism on the basis of a modified Ising model (recently discussed by Firgau for pure metals) the authors derive by statistical arguments relations for two statistical parameters, related to the degree of order and to the degree of parallelism of the elementary magnets respectively. These relations involve both the exchange interaction and binding interaction energies for neighbouring atoms. The equations are solved for representative values of the critical temperatures and relative interaction energies. The temperature variation of degree of order is also derived. E. P. WOHLFARTH

538.114 : 539.11

**5119. Statistical theory of the ferromagnetic superlattice. II. Anomalous specific heat and spontaneous magnetization.** T. MUTO, T. EGUCHI AND M. SHIBUYA. *J. Phys. Soc. Japan*, **3**, 284–8 (*Sept.–Dec.*, 1948).

Using the results of Part I (previous Abstr.) the temperature variation of specific heat and spontaneous magnetization is calculated for representative values of the critical temperatures and interaction energies involved. The results are discussed in relation to experimental data on $Ni_3Mn$ and $Ni_3Fe$. The treatment is extended to cover properties of quenched alloys. Future applications of the work are indicated. E. P. WOHLFARTH

538.13 : 621.318.423.013.2

**5120. Magnetic field calculations for large cross-section cloud-chamber coils.** H. W. KOCH. *J. Appl. Phys.*, **21**, 387–95 (*May*, 1950).

A method is described and equations are presented which permit the calculation of the magnetic field

characteristics of large cross-section air-core coils. The method is applied to the determination of the field non-uniformities on the median plane to be expected with annular cloud-chamber coils of rectangular cross-section. The field non-uniformity results are provided in graph form to facilitate the design of cloud-chamber coils. A.

538.213 : 537.311.62 : 621.318.22

**5121. Determination of the complex permeability of a substance from the complex permeability of a specimen by V. K. Arkadiev's method.** K. M. Polivanov. "*Problems of Ferromagnetism and Magnetodynamics*," *Moscow* (1946) 29–41. *In Russian.*

Differences in a.c. and d.c. magnetization are due: (1) to the additional field set up by eddy currents; (2) difference in the a.c. and d.c. permeabilities. Complex magnetic permeability defined by $B/\mu_0 H = \mu(1 - i \tan \delta)$, where $\mu$ is the "conservative," $\mu \tan \delta = \rho$ the "consumptive" permeability; both the real and imaginary parts may depend on frequency. The representation is valuable in the solutions of problems such as ferromagnetic screening, skin-effect, iron losses, etc. A comprehensive and clear exposition is given of Arkadiev's method, applied to specimens of sheet, tape and wire form, whose average permeability has been determined by conventional experimental methods. The formulae of the original theory and Arkadiev's nomograms are simplified for practical calculation purposes.

B. F. KRAUS

538.213 : 537.311.62 : 621.318.018.44

**5122. Electric skin-effect in a strip with a complex magnetic permeability.** V. K. Arkadiev and A. A. Dobrovolskaya. "*Problems of Ferromagnetism and Magnetodynamics*," *Moscow* (1946) 83–7. *In Russian.*

Tables and diagrams for the convenient evaluation of the coefficients of Polivanov's relations [*Dokl. Akad. Nauk, SSSR*, **32** (*No.* 3) 181 (1944)] for calculating resistance and internal inductance of a thin ferromagnetic strip. B. F. KRAUS

538.22

**5123. Magnetic properties of tin at low temperatures.** B. I. Verkin, B. G. Lazarev and N. S. Rudenko. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 773–6 (1949) *In Russian.*

A marked periodic field-dependence (de Haas–van Alphen effect) of the susceptibility of a Sn single crystal has been found. Some new observations on this effect in Bi are reported and it is mentioned that the effect has also been found in Be. [See also Abstr. 1071 (1950)]. D. SHOENBERG

538.22

**5124. On the magnetic moment of complex ions. I.** M. Kotani. *J. Phys. Soc. Japan*, **4**, 293–7 (*July–Dec.*, 1949).

538.22 : 541.183

**Magnetic measurements applied to adsorption.** *See Abstr.* 5389

538.22 : 621.318.2

**5125. Magnetic spectroscopy and its problems.** V. K. Arkadiev. "*Problems of Ferromagnetism and Magnetodynamics*," *Moscow* (1946) 7–27. *In Russian.*

A comprehensive survey of development. The modern problems outlined are: (1) Testing of technical materials (including a table of materials alre investigated and their relevant data); (2) theoret problems of magnetodynamics, the original the being compared with later refinements; (3) techn suitability of ferromagnetic materials for a.c. appli tions (a table of special materials and their optim frequency range is included). A bibliograp (1913–1945) is given of 57 items, 22 of them the author. B. F. KRA

538.22 : 621.318

**5126. Apparent permeability and $Q$-factor magnetic powders.** A. Colombani. *C.R. Acad. S Paris*, **230**, 523–5 (*Feb.* 6, 1950) *In French.*

Gives formulae for the real and imaginary pa of the apparent permeability of a magnetic powd and shows how these quantities vary with frequen A. E. De BA

538.2

**5127. The influence of the Weiss domains on t relation between the magnetic permeability of a su stance and frequency.** K. M. Polivanov. "*Proble of Ferromagnetism and Magnetodynamics*," *Mosc* (1946) 43–54. *In Russian.*

The fact that the apparent permeability of a ferr magnetic falls with increasing frequency, in a measu depending on the magnetic characteristics of t particular material, to approach unity at a wavelen of about 1 cm, is a deviation from Maxwell's theor This may, however, be explained not only by an actu variation of the permeability, but also by inhom geneities of the magnetized material over its cros section, which may be "macroscopic" and/ "microscopic." The latter are connected with t Weiss domains, whose boundaries shift with increasi frequency at first reversibly, and then irreversibl It is shown how a simple treatment based on distribution of the Weiss domains over a fini number of parallel layers of a sheet permits of a ver good approximation of the observed frequen relations of the apparent permeability and of t damping of incident waves of magnetic field intensit (Bibliography of 19 entries.) B. F. KRA

538.22

**5128. Theory of magnetic properties of poly crystalline ferromagnetics in weak and medium field** E. J. Kondorski. "*Problems of Ferromagnetism an Magnetodynamics*," *Moscow* (1946) 97–127. *Russian.*

Hysteresis and magnetization is first considered i absence of interreaction between the crystals b comparing the re-magnetization and magnetizatio of ferromagnetics with a rectangular hysteresis loo and establishing the dependence of the area of th loop and the coercive force on specimen shape. A approximate theory is given for a ferromagneti consisting of infinitely long parallel cylindrica "grains." This theory is checked by experiment with cold-drawn Ni–Fe and Ni wires, considering th influence of tensile stresses. The agreement is striking The theory is then extended to include interactio between single grains (crystallites) or grain complexes The given equation of the magnetization curve of a idealized polycrystalline medium coincides sur prisingly well with the test curve of heat-treate Fe wire. B. F. KRAU

538.221

**9. The temperature dependence of initial permability of iron single crystals under external tension.** TOMONO. *J. Phys. Soc. Japan*, **4**, 196–8 (*July–*, 1949).

538.221

**0. On the properties of [a] ferromagnetic alloy manganese and bismuth at low temperature. 1. gnetic, dilatometric and calorimetric studies.** KONDO. *J. Phys. Soc. Japan*, **5**, 26–30 (*Jan.–Feb.*, 0).

Experimental studies on MnBi indicate that fields ond $2\times10^4$ oersted are required to attain saturaon at room temperature; the magnetic moment per Bi molecule is $> 2\cdot6\,\mu_B$; $\sigma$ decreases abnormally h $T$, at first rapidly and then more gradually, ween −150°C and room temperature, with a Curie nperature of about 350°C; the expansion coefficient l specific heat show anomalies near −150°C.

E. P. WOHLFARTH

538.221

**1. Magnetization curves and energies, coercive ce and magnetostriction of a cobalt ferrite.** C. ILLAUD, R. VAUTIER AND S. MEDVEDIEFF. *C.R. ad. Sci., Paris*, **230**, 60–2 (*Jan.* 2, 1950) *In French.*

Gives values for the ferrite known as Vectolite at ° and 77°K, both unquenched and quenched, with l without orientation by cooling in a magnetic field. ercive forces up to 6 300 oersted are recorded.

C. E. WEBB

538.221

**2. Effect of exchange interaction on ferromagnetic rowave resonance absorption.** C. KITTEL AND C. RRING. Letter in *Phys. Rev.*, **77**, 725–6 (*March* 1, 0).

Exchange effects are not negligible in pure metals low temperatures. It is shown, for instance, that contribution to the line width from exchange effects f the same order as the extra contribution to the d at liquid H temps. It is therefore to be expected t the line width of pure Fe, Ni and Co single stals will increase appreciably at low temperatures.

G. F. HODSMAN

538.221 : 538.662.15

**3. Ferromagnetic properties of manganese-imony and manganese-arsenic alloys.** C. GUILLAUD. *n. Phys., Paris*, **4**, 671–703 (*Nov.–Dec.*, 1949) *In nch.*

A detailed study of the variation of magnetization h $H$ and temperature in both alloy systems, ding evidence of a number of definite compounds. particular $Mn_2Sb$ was obtained as a single crystal l its magnetocrystalline energy was determined as unction of temperature. In MnAs a transformaı point at 45°C was indicated magnetically and firmed by specific heat, X-ray, dilatometric and trical resistance observations. The phase diam of each system is deduced from the atomic gnetic moments and Curie points. C. E. WEBB

538.222

**4. Magnetic susceptibility of metals dissolved in id ammonia.** E. HUSTER. *Ann. Phys., Lpz. lge* 6) **4** (*No.* 3–4) 183–90 (1948) *In German.*

The susceptibility of solutions of Ca in liquid $NH_3$ at −35°C and −75°C and corrected values of the susceptibility of solutions of Na at the same temperatures are communicated and compared with values obtained by Freed and Sugarman [Abstr. 230 (1944)] for $NH_3$-solutions of K, Cs, Ca and Ba. Variations of susceptibility with concentration and temperature are discussed and the bearing of these data on the behaviour of free conductivity electrons in the solution is considered. W. R. ANGUS

538.222

**5135. The paramagnetic resonance absorption in crystalline powders of some compounds of the rare earth elements.** S. A. ALTSHULER, V. YA. KURENEV AND S. G. SALIKHOV. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 201–4 (1950) *In Russian.*

Measurements of the paramagnetic resonance absorption of electrons in the deep 4*f* shells were made with a measuring $H$ field perpendicular to the static $H$ field and with a frequency of 675 Mc/s; concordant results were obtained at 238 Mc/s. Maximum absorptions were found at: 1 100 oersteds for $Pr_2(SO_4)_3\,.\,8H_2O$ and $Pr(NO_3)_3\,.\,6H_2O$; at 750 oersteds for $Pr_2(SO_4)_3$, $Nd_2(SO_4)_3\,.\,8H_2O$, $Nd(NO_3)_3\,.\,6H_2O$ and $Er(NO_3)_3\,.\,5H_2O$, the last peak having a pronounced shoulder at 400 oersteds; 550 oersteds for $Ce(CO_3)_3\,.\,5H_2O$; 1 400 oersteds for $Sm_2O_3$. All the peaks are single with widths at half heights from 500 to 1 500 oersteds. Interpretation indicates the absence of cubic symmetry of the electric field of the crystal in most cases. D. H. WHIFFEN

538.222

**5136. On the paramagnetic susceptibilities of some polynuclear complex salts.** K. KAMBE. *J. Phys. Soc. Japan*, **5**, 48–51 (*Jan.–Feb.*, 1950).

Quantum-mechanical theory.

538.222

**5137. On the properties of magnesium ferrite at high temperatures.** G. FOËX AND A. SERRES. *C.R. Acad. Sci., Paris*, **230**, 729–30 (*Feb.* 20, 1950) *In French.*

538.222

**5138. Fine structure of the magnetic resonance line of protons in $CuSO_4\,.\,5H_2O$.** N. BLOEMBERGEN. *Physica*, **16**, 95–112 (*Feb.*, 1950).

The magnetic resonance, at 30 Mc/s, of protons in a single-crystal of $CuSO_4\,.\,5H_2O$ consists of a single line about 14 oersteds wide, at room temperature. A splitting of this line into 10 component lines has been observed at low temperatures. The maximum over-all separation at 1·2°K is over 600 oersteds. The position and width of each line are complicated functions of the direction of the externally applied magnetic field in the crystal. For each direction of the external field the separations between the lines increase with decreasing temperature. Theoretical formulae for the position of the component lines are developed by considering the proton two-spin system within a water molecule of hydration immersed in the external field and the inhomogeneous time-averaged field of the cupric ions. Exchange and saturation effects are taken into account up to terms in $1/T^3$. At low temperatures the field of the Cu ions effectively decouples the ortho-para-coupling between the proton spins. It is estimated that the splitting between ortho- and para-states is small, and probably no

larger than the magnetic interaction between the protons. Expressions for the line width are also derived. It is shown that the Cu-ions do not contribute to the width, as a consequence of the large exchange between them. The fluctuating field of the Cu-ions, however, is responsible for the short relaxation time $T_1$. The experimental upper limit for $T_1$ at all temperatures is 0·01 sec. A.

538.222

**5139. Paramagnetic susceptibilities and electronic structures of aqueous cations of elements 92 to 95.** J. J. HOWLAND, JR. AND M. CALVIN. *J. Chem. Phys.*, **18**, 239–43 (*March*, 1950).

538.222

**5140. Paramagnetic resonance absorption in titanium caesium alum at low temperatures.** D. BIJL. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 405–6 (*April*, 1950).

538.222

**5141. Anisotropy in titanium alum.** B. BLEANEY. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 407–8 (*April*, 1950).

538.222

**5142. Paramagnetic resonance in copper fluosilicate.** B. BLEANEY AND D. J. E. INGRAM. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 408–9 (*April*, 1950).

538.222

**5143. Theoretical interpretation of copper fluosilicate spectrum.** A. ABRAGAM AND M. H. L. PRYCE. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 409–11 (*April*, 1950).

538.222

**5144. Paramagnetic resonance in copper sulphate.** D. M. S. BAGGULEY AND J. H. E. GRIFFITHS. *Proc. Roy. Soc. A*, **201**, 366–77 (*April* 26, 1950).

Paramagnetic resonance absorption in single crystals of $CuSO_4 . 5H_2O$ has been investigated at wavelengths of 3·04, 1·23 and 0·85 cm. Only one absorption line is found at wavelengths of 3·04 and 1·23 cm, and the position agrees with that calculated from susceptibility data. Two lines would be expected theoretically for many orientations of the crystal in the magnetic field, corresponding to the two inequivalent $Cu^{++}$ ions in unit cell. At 0·85 cm wavelength two lines are found under the appropriate conditions but not at longer wavelengths. This is interpreted in terms of exchange interaction between dissimilar ions, and the exchange frequency is estimated at $0{\cdot}15\ cm^{-1}$. Other effects of exchange interaction in this salt are discussed. A.

538.23

**5145. Thermal changes in irreversible magnetization.** P. RHODES. *Proc. Leeds Phil. Lit. Soc.*, **5**, 116–27 (*Dec.*, 1948).

Calculations are made for an idealized substance consisting of single-domain ferromagnetic particles with uniaxial anisotropy dispersed in a non-ferromagnetic matrix [Abstr. 1877 (1948)]. Numerical values of the internal, thermal and internal magnetic energy are given, as dependent on field and magnetization, for the initial and cyclic magnetization curves. A relation between the hysteresis loss and the coercivity, intensity of magnetization and concentration of the ferromagnetic phase is derived.

E. P. WOHLFARTH

538.3

**5146. On the displacement velocity of the doma boundary of ferromagnetic substance.** T. KATAYAM *J. Phys. Soc. Japan*, **3**, 202–7 (*July–Aug.*, 1948).

A theoretical approach is made by constructing t eigenfunction which approximately corresponds the Bloch solution [*Z. Phys.*, **74**, 295 (1932)] for magnetic wall, and treating the wall displaceme as the transition phenomenon between the sp states designated by these eigenstates. It is shov that only the transversal lattice waves having wa number vectors perpendicular to the boundary surfa take part in the magnetic wall displacement and al that the propagation velocity is ∝ the field, but t temperature does not appear explicitly in its expre sion. It is claimed that this approach gives a qua tative explanation of the discrepancy betwee experimental results and the electrodynamical theor

G. F. HODSMA

538.

**5147. On the velocity of displacement of [a] magnet domain boundary.** T. HUZIMURA AND T. KATAYAM *J. Phys. Soc. Japan*, **4** (*No.* 3) 163–6 (*March–Apr* 1949).

A theoretical conclusion that the velocity is ind pendent of temperature if no eddy currents a induced is verified by means of measurements of th Barkhausen effect in non-metallic $Fe_3O_4$ at 10°C ar — 140°C. E. P. WOHLFART

538.

**5148. A theory of initial permeability.** S. MIY HARA. *J. Phys. Soc. Japan*, **5**, 8–10 (*Jan.–Feb.*, 1950

By considering dislocation centres as impedi domain boundary movement by means of changes the surface energy in their immediate vicinity th author derives a relation for initial permeabili which, with representative values of domain surfa energy per unit area, surface area per unit volum average distance between dislocation centres an saturation magnetization gives satisfactory agreeme with observed values for iron. E. P. WOHLFART

538.2

**5149. Calculation of the second constant of magneti anisotropy in the law of approach to saturatio** L. V. KIRENSKIĬ AND L. I. SLOBODSKOĬ. *Dokl. Akad Nauk, SSSR*, **69** (*No.* 5) 639–42 (1949) *In Russian.*

The generally accepted relation for the magne ization in strong fields ($I > 0{\cdot}971_0$) is $I = I_0(1 - a/H - b/H^2 - c/H^3) + \chi_p H$, where $I_0$ is th spontaneous magnetization at the given temperature $b = 8/105\ k_1^2/I_0^2$ ($k_1$ being the first energetic constan of the magnetic anisotropy), but was later found als to depend on the second constant of anisotropy, $k$ The paper gives a calculation of $c$ in terms of $k$ and $k_2$ and $I_0$. It is obtained as a homogeneou 3rd order polynomial of $k_1$ and $k_2$ over $I_0^3$. Thi derivation holds only in the absence of mechanica stresses and the above law is at least semi-empirical.

B. F. KRAU

538.2

**5150. Crucial experiment demonstrating singl domain property of fine ferromagnetic powders** C. KITTEL, J. K. GALT AND W. E. CAMPBELL. Lette in *Phys. Rev.*, **77**, 725 (*March* 1, 1950).

Single domain effects were to be distinguished fro

c magnetization processes in spherical Ni particles ersed in a non-ferromagnetic matrix, by measuring field required to attain saturation in (*a*) very ll (presumed single-domain) particles (200 Å), larger particles (8 $\mu$). For (*a*) $H_s \simeq 2K/I_s$ (more here is agglomeration), the observed value being oersted. For (*b*) $H_s \geqslant 4\pi I_s/3 = 2\,100$ oersted, value observed. It is concluded that (*a*) referred single domains. In summarizing the idea of the eriment a demagnetizing energy $2\pi I_s^2/3$ is ascribed saturated sphere which, with multi-domain but with single-domain particles, must be supplied he external field. E. P. WOHLFARTH

538.245

**1. On the direction of the spontaneous magzation of ferromagnetic bodies.** P. HENRY. *. Acad. Sci., Paris*, **230**, 55–6 (*Jan.* 2, 1950) *In nch.*

pplies Curie's principle of the symmetry of ses and effects to the combined influence of heat , mechanical force and magnetic field with results ch explain the observed residual magnetism of lies cooled through the Curie point under severe hanical constraint in the earth's magnetic field. C. E. WEBB

538.245

**2. A quantitative study of the domain structure single crystals of silicon-iron by the powder pattern nique.** L. F. BATES AND F. E. NEALE. *Proc. s. Soc., Lond. A*, **63**, 374–88 (*April*, 1950).

quantitative study of the domain structure of gle crystals of silicon-iron has been made by the wder pattern method, special examination being de of the patterns formed on a strip specimen ose surface was approximately a (100) plane with a 1] direction parallel to the long edge of the strip. Mode III magnetization, which occurs when a d acts inside the specimen parallel to the [011] ection, the line deposits formed at right angles reto were on the average spaced in good accord a Néel's theory in the case of wide strips, but in good accord for narrow strips. Qualitative lts of other measurements on strip and disc imens are reported and interpreted. A.

538.245 : 539.217

**3. The energy of activation in super-structure versions.** N. S. AKULOV AND E. N. SVIRINA. *l. Akad. Nauk, SSSR*, **70** (*No.* 5) 789–91 (1950) *In sian.*

he mechanism of atomic diffusion, very important the determination of the rate of super-structural versions, may be of a dual kind: direct interchange places between any 2 atoms, and "empty place usion," i.e. occupation of lattice nodes for any son unoccupied. That the latter is the more bable process can be shown by quantum-mecha- al calculations. The diffusion rate depends ntially on the height of the energetic barrier to overcome by the atoms in the interchange or upation of neighbouring vacuoles. Considerations disorder-order and relaxation phenomena are her important factors, and it is here that diffi- ies arise for a number of alloys, mainly on the erimental side of the determination (usually X-ray or neutron scatter methods). The new theory of super-structural alloys shows that the variation of the magnetic moment is a linear function of the "nearest order of $\sigma$," $\sigma$ being the degree of order. It can be shown that the magnetic saturation is in a quadratic relation to concentration and depends linearly on $\sigma$. This theory was applied to the investigation of annealed permalloy and the temperature-dependence of the magnetic moment enabled $\sigma$, $\tau$ and $E$ to be determined where $\tau$ is relaxation time and $E$ activation energy. The latter was found as 1·7 eV = 39 kgcal/mole. B. F. KRAUS

538.247

**5154. Limiting demagnetizing factors of a cylinder.** V. K. ARKADIEV. "*Problems of Ferromagnetism and Magnetodynamics*," *Moscow* (1946) 129–32. *In Russian.*

For obtaining saturation magnetization in all parts of an Fe cylinder, a field of 10 000 Oe is necessary. The values of the demagnetizing factor obtaining then are known as limiting values. The two interesting values of the local demagnetizing factor, viz. the central or ballistic factor $= 2\pi/\Lambda$ and the mean or magnetometric factor $= 2\,\pi/\Lambda^2$ are found by integration of the magnetostatic equations. Curves of the Rayleigh shift are given and compared with an experimental curve. B. F. KRAUS

538.247

**5155. On the internal factor of demagnetization of highly coercive alloys.** N. V. BULGAKOV. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 205–6 (1950) *In Russian.*

538.247

**5156. Apparent demagnetization.** L. A. YUROVSKI. "*Problems of Ferromagnetism and Magnetodynamics*," *Moscow* (1946) 93–6. *In Russian.*

It is easy to show theoretically that, owing to skin-effect, the demagnetization carried out by the usual procedure with cycles of decreasing amplitude penetrates only a few mm below the surface of a cylindrical specimen of several cm dia. It was shown experimentally by dissolving the surface layers with aqua regia, after apparent demagnetization in the conventional set-up. The experimental curves reveal that, whilst the character of the phenomenon remains the same, the penetration of the demagnetization is far deeper for a demagnetizing field starting with amplitudes several times > the original magnetizing field and slow cycles ($t > 3$ sec). A.c. demagnetization starting at about the magnetizing field strength has the shallowest penetration. B. F. KRAUS

## ELECTROMAGNETISM . ELECTRODYNAMICS
## 538.3/.5

538.3

**5157. The electric and magnetic vortex sheets on moving bodies.** T. SCHLOMKA. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 3–5) 190–6 (1949) *In German.*

A vector field, vanishing at $\infty$, may be calculated in a well-known way from its source and vortex distributions in space and on its surfaces of discontinuity. For an infinite space containing a charged and magnetized body the calculation of the

electric and magnetic fields set up, as judged by an observer relative to whom the body is in motion, encounters the difficulty that no formulae for the vortex sheets have been derived in the literature. Such formulae are here obtained. P. M. DAVIDSON

538.3

**5158. A simple method of obtaining expressions for electric and magnetic field vectors by means of magnetic and electric Hertz vectors.** S. V. STRAKHOV. *Elektrichestvo* (*No.* 2) 43–6 (*Feb.*, 1950) *In Russian.*

The method of integrating Maxwell's equations by the introduction of the magnetic and electric Hertz vectors by retarded potentials is well known from radio wave propagation theory. It is shown how to describe the field by either an electric or a magnetic Hertz vector of a dipole of the corresponding character, the magnetic or electric moment of which may be an arbitrary function of time. Some possible formal errors in using the method are pointed out.

B. F. KRAUS

538.3 : 530.12

**5159. Relativity and unipolar induction.** T. SCHLOMKA; G. SCHENKEL. *Ann. Phys., Lpz.* (*Folge* 6) **5** (*No.* 1–2) 51–62 (1949) *In German.*

Relativistic formulae are given for the electric field, polarization and charge distribution produced by a slowly rotating magnet, in particular by a uniformly magnetized sphere. The author finds that the expression for the density of the true charges differs from the expression given by the absolute theory by terms of the first order in $v/c$.

L. PINCHERLE

538.311 : 621.316.73 : 621.318.34

**5160. A magnetic field stabilization circuit.** L. KATZ, P. A. FORSYTH, L. F. CUDNEY, G. W. WILLIAMS, H. E. JOHNS AND R. N. H. HASLAM. *Canad. J. Res. A*, **28,** 67–72 (*Jan.*, 1950).

Describes the apparatus used to stabilize the magnetic field of a large electromagnet. A rotating coil placed in the magnetic field generates an alternating voltage which is $\propto$ the strength of the field. Variations in this rotor voltage are used to control the current supplied to the electromagnet so as to keep the field constant. By means of a calibrated field control the magnetic field strength may be adjusted to any value between 500 and 6 000 gauss. The current for the electromagnet is obtained by rectifying 60 c/s a.c. in a full-wave thyratron, rectifier circuit. This current is controlled by a pulse circuit which governs the conducting cycle of the thyratrons. The stabilization at any field setting is better than 1 part in 1 000.

A.

538.311 : 621.318.4.013.2

**5161. The magnetic field inside a solenoid.** J. R. BARKER. *Brit. J. Appl. Phys.*, **1,** 65–7 (*March*, 1950).

Gives convenient formulae for computing the magnitude of the region of uniform field inside the coil, and tables for simplifying the design of a solenoid.

A.

538.566 : 535.42 : 621.396.11

**5162. Errata: On the diffraction of an electromagnetic wave through a plane screen.** J. W. MILES. *J. Appl. Phys.*, **21,** 468 (*May*, 1950).

See Abstr. 1098 (1950).

538.566 : 621.3.011.5 : 621.3.016.1.029

**5163. Ponderomotive effects in the centimetre wa region and the possibility of their use for measurem purposes. I. The Born–Lertes rotating field effect dipolar fluids in the centimetre-wave region.** H. BOMKE AND T. SCHMIDT. *Arch. elekt. Übertragung* 33–5 (*Jan.*, 1950) *In German.*

A general formula is deduced for the torque act on a dipolar liquid in a rotating electric field (c cularly polarized wave). By using experimental da for the permittivities it is shown that the max. torc exists at the following wavelengths:—water 9 c $CH_3OH$ 25 cm; $C_2H_5OH$ 40 cm. T. S. E. THOMAS

538.566 : 621.396.

**5164. The Fresnel reflection formula in the long wavelength range.** E. ROESCHEN. *Funk u. Ton*, 525–8 (*Sept.–Oct.*, 1949) *In German.*

A short paper giving the results of measurements the field intensity in the medium (water) between radiating vertical aerial and a submerged metal pla Curves are given for the wavelengths 217, 437 a 1 450 m and the underlying theory is briefly discusse

W. J. G. BEYNON

538.566 : 621.396.

**5165. Radiation from a transverse slot in an infin cylinder.** C. H. PAPAS. *J. Math. Phys.*, **28,** 227– (*Jan.*, 1950).

538.566

**5166. Propagation of electromagnetic disturban along a thin wire in a horizontally stratified mediu** B. L. COLEMAN. *Phil. Mag.*, **41,** 276–88 (*Marc* 1950).

It is shown that for a thin wire buried at a fini depth in a semi-infinite homogeneous medium an subject to a disturbance at a given frequency, the exists an exponential attenuation of the current the wire with a propagation constant equal to th of the medium. This result is extended to a mediu with a number of layers, and to a wire lying in a interface.

538.566.2 : 621.392.2

**5167. Application of the Picard approximatio method to the study of waveguide discontinuitie** T. KAHAN. *C.R. Acad. Sci., Paris*, **230,** 527– (*Feb.* 6, 1950) *In French.*

Picard's approximation method is applied to th problem of a waveguide whose section is uniform up to a plane $z$ and then slowly varies. The solutio is found as a rapidly converging series of integral containing the solution of the unperturbed problem The same method can be used for variations c conductivity, permittivity or permeability.

A. H. W. BEC

538.566.2 : 621.396.1

**5168. The influence of weather conditions on lon distance short wave transmission.** N. S. SUBBA RA AND Y. V. SOMAYAJULU. *Proc. Indian Acad. Sci. A* **31,** 42–55 (*Jan.*, 1950).

The field strengths at Waltair, of signals radiate from Madras, Calcutta and Bombay stations of th All India Radio on the 41 and 49 m bands, hav been studied over a period of 7 months. Th measurements have been made between 7.30 hr t 9.00 hr Indian Standard Time daily. The day-to

variations of the field strengths of the received nals are presented, month by month, in the form graphs and discussed. The study of these curves ws that: (1) During the wet season there is a inite relationship between the field strengths of the eived signals and the percentage humidities in the nosphere along the path of the wave—a rise or in humidity producing a corresponding fall or in the received signal strengths. (2) Further, se effects are more pronounced when the per-tage humidities are 85%. (3) In cases where the midities are much lower, there appears to be no ation between these two quantities. This abnormal nsmission, especially during the wet season, is ced to reflection at low levels, produced by clouds zones of condensation or by water vapour molecules emselves. A.

538.566.3 : 551.594.6

**Deflection from vertical path in ionosphere.** *See str.* 5468

538.567 : 621.396.11

**59. Reflection of electric waves on the wires of a rtz screen parallel to the magnetic vector.** O. I. OZINETS. "*Problems of Ferromagnetism and agnetodynamics*," *Moscow* (1946) 89–92. *In Russian.* The case of ferromagnetic screens was treated by kadiev, but only for wires parallel to the electric ctor. The present treatment is based on Gans' ory and determines the coefficients of reflection, sorption and transmission of the screen. A com-rison of the results applied to an Fe grid of dimen-ns equal to those of the Cu grid used in Hertz' periments shows the reflective property of the Fe id to be about 300×, absorption about 20× that Hertz grid. B. F. KRAUS

## MAGNETIC EFFECTS 538.6

538.6 : 532.517.4

**On the spontaneous magnetic field in a conducting quid in turbulent motion.** *See Abstr.* 4744

538.63 : 537.312.8

**Theory of magnetic resistance effects in metals.** *e Abstr.* 5000

538.63 : 537.312.8

**Magnetic resistance change.** *See Abstr.* 5001–2

538.632

**70. Hall effect for Zn at low temperatures.** . S. BOROVIK. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 4) 1–3 (1950) *In Russian.*

The Hall and magnetoresistance effects have been udied on a single crystal of Zn, with its hexagonal is nearly parallel to the current direction, at 78°K, ·4°K and 4·2°K. The ratio of the electric fields rpendicular and parallel to the magnetic field $H$ sses a maximum value when $H$ makes the radius curvature of the electron paths comparable with e mean free path (about 14 000 gauss at 20·4°K nd 4 000 gauss at 4·2°K). The maximum value is 0·16 at 20·4°K and ~ 0·03 at 4·2°K. It is pointed t that similar effects can be traced in previous ork on Bi and Cd. D. SHOENBERG

538.632

**5171. Correlation of Geiger counter and Hall effect measurements in alloys containing germanium and radioactive antimony 124.** G. L. PEARSON, J. D. STRUTHERS AND H. C. THEUERER. *Phys. Rev.*, **77**, 809–13 (*March* 15, 1950).

The distribution of the solute atoms in ingots of Ge–Sb alloys which were prepared according to a prescribed cooling cycle have been measured. The solute was $Sb^{124}$ and its distribution was measured with a Geiger counter. In addition, Hall measurements were made which show that in the impurity saturation range each Sb atom contributes one conduction electron. This makes it possible to determine the solute distribution in non-radioactive samples by the Hall method. A.

538.632 : 537.312.8 : 537.311.31

**Electric resistance, magneto-resistance, and Hall effect, of the alkali metals.** *See Abstr.* 4965

538.652

**5172. Reversible longitudinal magnetostriction of nickel in zero field.** J. PALACIOS AND D. GUINEA. *An. Real Soc. Esp. Fis. y Quim.*, **45A**, 407–20 (*Sept.–Oct.*, 1949) *In Spanish.*

The longitudinal magnetostriction of a small Ni rod, previously magnetized and submitted to compression along its axis, was studied during the cyclical transformations which comprise its initial state, by means of a very sensitive extensometer. The values of the magnetostriction coefficient thus obtained were compared with the calculated ones which are based on the direct measures of Villari's longitudinal effects by the formula of Becker and Kersten, modified by Palacios and Lozano [*ibid.*, 387, 629 (1944)]. Hysteresis was observed even in small transformations. A.

538.652

**5173. Study of the static and dynamic magneto-strictive properties of austenitic Fe–Ni alloys.** H. DEVÈZE. *Ann. Phys., Paris*, **5**, 80–144 (*Jan.–Feb.*, 1950) *In French.*

Apparatus described includes an optical lever and interference system, electromagnet, temperature control, magnetometer, variable frequency generator, continuous current generator and supersonic wave emission and observation equipment. The static measurements included those of $(\Delta l/l)$ as function of $B$ and $H$ for alloys with 30–100% Ni, including invar. An empirical relation $(\Delta l/l)\times 10^6 = (B/B_0)^\lambda$ is used. Dynamic measurements included those of the amplitude and frequency variation of the magneto-strictive oscillations emitted by the alloy specimens, for given alternating and different magnetizing fields, and vice versa. The measurements are correlated by given theoretical expressions and with the static measurements. Temperature dependence was also investigated. Bearing of the work on supersonic generators is discussed. E. P. WOHLFARTH

538.653

**5174. Distinction between the apparent elastic limit and the magnetic reversibility limit of steel under tension.** A. LANGEVIN, E. PAUL AND M. REIMBERT. *C.R. Acad. Sci., Paris*, **230**, 715–17 (*Feb.* 20, 1950) *In French.*

Simultaneous elastic and magnetic experiments on

a steel rod under static tension indicate the existence of a region intermediate between the magnetic and mechanical reversibility limit on the one hand and the apparent elastic limit on the other, this region being characterized by residual strains of the order $10^{-6}$ to $10^{-4}$. E. P. WOHLFARTH

538.653.11

**5175. The magnetization curve of nickel under tension.** O. Buhl. *Z. Naturforsch.*, **4a**, 601–5 (*Nov.*, 1949) *In German.*

Plotting magnetization against reduced field-strength, $H/H_c$, a constant curve is obtained at all tensions above a very low value, differing widely from that obtained before and after loading. This indicates that the distribution of internal stress remains the same under tension but differs from that in the absence of external load. Further, the "ideal" magnetization curves at various tensions yield a common reduced curve, and a theory accounting for this is given, based on the existence of an internal leakage field, support for which is provided by the proportionality maintained between $H_c$ and the demagnetizing factor as the load is varied. C. E. WEBB

538.69 : 536.212.2

**The thermal conductivity of metals in a strong magnetic field.** *See Abstr.* 4904

## THEORY OF SOLID STATE 539.11

539.11

**5176. Electronic properties and band structure of palladium and platinum.** E. P. Wohlfarth. *Proc. Leeds Phil. Lit. Soc.*, **5**, 89–101 (*Dec.*, 1948).

The three parameters specifying the band structure of the two metals, viz. (i) the number of holes per atom in the *d* band, (ii) the Fermi–Dirac characteristic temperature, (iii) the interchange interaction coefficient, are estimated from a variety of magnetic and thermal properties of the metals and their alloys. The values derived for Pd are in satisfactory agreement, but for Pt they are less certain.

E. P. WOHLFARTH

539.11

**5177. An approximate theory of order in alloys.** J. M. Cowley. *Phys. Rev.*, **77**, 669–75 (*March* 1, 1950).

Short-range order parameters $\alpha_i$ are defined to express the interaction of a given atom in an alloy with the atoms of the *i*th shell of atoms surrounding it. From simple thermodynamic reasoning, involving a certain degree of approximation, equations relating the $\alpha_i$ with energy terms and the temperature are derived. Equations for the long-range order parameter, *S*, are obtained by considering the limiting case of *i* very large. The values of the long- and short-range order parameters obtained by solving these equations are in good agreement with experimental values recently found by X-ray diffraction methods. The theory is extended to the calculation of configurational energy and specific heat, and to the determination of order parameters for alloys of arbitrary composition in such binary systems as th of the Cu–Au alloys. In these cases qualitati agreement with experimental observations is obtaine

539.11 : 530.1

**5178. Erratum: Quasi-chemical method in th statistical theory of regular mixtures.** Y.-Y. L Letter in *Phys. Rev.*, **77**, 300 (*Jan.* 15, 1950).

See Abstr. 1894 (1950).

539.11 : 537.31

**5179. The electron-history and the relaxation tim problem in the electron theory of solid conductors** W. Schottky. *Ann. Phys., Lpz.*, **6**, 193–214 (194 *In German.*

Methods of determining the distribution function of electrons in the 6-dimensional co-ordinate momentum phase space are discussed, with specia reference to the Boltzmann equation of state. Thi equation is derived and compared with the approach due to Riecke and Drude. The familiar assumption $(f_0 - f)/\tau$ for the collision operator ($f_0$ unperturbe distribution function, $\tau$ time of relaxation) is dis cussed, and reasons are given for the belief that it i unsuitable for electrons in a crystal. Writing $f = f_0 + \Sigma_1^6 f_j$, the collision operator for each per turbing function $f_j$ is found in the form $(f_0 - f_j)/\tau_j$ and equations are established for the $\tau_j$. The dis cussion is classical and the effect of the Fermi statistics is not considered. P. T. LANDSBERG

539.11 : 539.153.2 : 548.7

**5180. Structural investigations by means of nuclear magnetism. II. Hindered rotation in solids.** H. S. Gutowsky and G. E. Pake. *J. Chem. Phys.*, **18**, 162–70 (*Feb.*, 1950).

The experimental absorption line widths, for nuclei with spin $\frac{1}{2}$, at nuclear magnetic resonance are given as a function of temperature for a number of molecular crystals. Temperatures ranged from 90°K to the melting points of the compounds. In some cases it has been possible to relate observed line structure and transitions in the line width to the existence and frequency of certain types of hindered rotational motion in the solid state. These deductions are based on mathematical considerations of the quantitative effect of such motions on the structure and second moment of an absorption line. It is emphasized that relatively low frequency motion of the order $10^5$ c/s suffices to narrow the width of an absorption line from its value in the absence of that motion. 1, 2-dichloroethane, 1, 1, 1-trichloroethane, and perfluoroethane were found to have line-width transitions coinciding with changes in crystal form and anomalies in the heat capacity. In 1, 2-dichloroethane and perfluoroethane these transitions correspond to rotational motion about the long axis of the molecule. 1, 1, 1-trichloroethane has a line-width transition corresponding to this type of motion, but the heat capacity anomaly and change in crystal form coincides with a further small decrease in the line width to that characteristic of the liquid. A number of molecules including acetonitrile, methyl iodide, nitromethane, dimethyl mercury and ammonia have absorption lines at 90°K corresponding to molecular rotation about the $C_3$ figure axis. Various other data and interpretations are presented for 2, 2-dimethyl

ane, methanol, ethanol, acetone, methylamine
he ethyl halides. The possibility of estimating the
ntial barriers hindering rotation in solids from
ne-width transitions is discussed. A.

## MOLECULAR STRUCTURE 539.13

539.132

**. On the frequency of molecular oscillations.** OVERA. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Mat. Nat.*) **2,** 318–20 (*March*, 1947) *In Italian.*
new experimentally derived formula is proposed.
king by Mecke's formulae and tables shows a
agreement. G. RIGHINI

539.132

**. The energy of localization.** J. A. A. ELAAR AND J. VAN DRANEN. *Rec. Trav. Chim. -Bas*, **69,** 477–81 (*March*, 1950).
he energy of localization of one pair of $\pi$-electrons
lculated for benzene and for naphthalene, in the
r case for the 1–2 bond and for the 2–3 bond.
usual L.C.A.O. approximation of the molecular
tal method is applied in zero approximation with
ect of overlapping integrals and in first approxi-
on with these integrals equal to 0·25. The
es found in the zero approximation are 27·4
zene), 22·7 (1–2 bond naphth.) and 31·2 kcal.
bond naphth.): in a first approximation 30·2,
3 and 36·3 kcal. respectively. The observed
rence in the rate of the reaction of ozone with
zene and naphthalene is in accordance with these
lts. A.

539.132 : 530.145.6

**3. On the quantum mechanics of regular struc-
s of finite extent.** S. FLÜGGE. *Ann. Phys., Lpz.*,
01–6 (1948) *In German.*
one-dimensional structure is considered with a
odic sequence of a finite number $N$ of potential
s. The reflection and transmission coefficients of
ave falling upon such a model of a chain molecule
determined. For every energy a number $N$ exists
g rise to complete transmission. J. JACOBS

539.132 : 548.7

**fra-red activities of vibrations in quartz.** *See
r.* 5420

539.133

**1. The size of silicone molecules.** T. G. ROCHOW
E. G. ROCHOW. *Science*, **111,** 271–5 (*March* 17,
0)).

539.133

**5. Influence of the overlap integral in molecular-
tal calculations for alternant hydrocarbons.** J. DE
R. *Phil. Mag.*, **41,** 370–81 (*April*, 1950).

539.133 : 535.417

**6. Direct optical measurement of the length of
nic molecules.** J. S. COURTNEY-PRATT. *Nature*,
*d.*, **165,** 346–8 (*March* 4, 1950).
y using the multiple-beam interference methods of
ansky the thickness is determined for monomole-
r layers of stearic acid and octacosanoic acid.
monolayers are spread on muscovite mica which is silvered on both sides. The small thickness step is then measured using white light fringes of equal chromatic order. The steps are readily seen in the fringe patterns. The value found optically for the molecular length of stearic acid is $19 \pm 3$ Å which compares with a predicted X-ray value of 24·42 Å, The value found for octacosanoic acid is $30 \pm 1\frac{1}{2}$ Å, compared with an X-ray predicted value of 37·02 Å. The discrepancy is attributed to phase change effects on reflection at the silver layer leading to spurious thickness. This is supported in that the difference (11 Å) between the optical lengths of these molecules is close to the X-ray difference (12·6 Å). By traversing the specimens across the line of the spectrograph slit, it has been possible to examine methodically the whole of the areas over which the organic materials had been spread. Near the lateral boundary of a layer there is a decrease in its apparent thickness. Away from the boundary the layer is uniform. Polymolecular layers are absent. The method therefore provides direct and independent evidence that the molecules of fatty acids spread by the retraction technique are adsorbed on the surface as a uniform monomolecular layer. S. TOLANSKY

## ATOMIC STRUCTURE . ISOTOPES 539.15

539.15

**5187. The empirical atomic form factors of neon, argon, krypton and xenon.** E. LAURILA. *Ann. Acad. Sci. Fennicae, Ser. A*1, *Paper* 27, 8 *pp.* (1944) *In German.*

With the aid of experimental values for Xe and for a Xe–Kr mixture the scattering factor for pure Kr is determined; hence also the atomic form factors for the 4 gases. These compare well with theoretical curves except A which shows a systematic deviation from the Hartree curves. J. JACOBS

539.152

**5188. Supplementary observation on our work "General solution of the H-atom with arbitrary initial conditions. . . ."** H. KALLMANN AND M. PÄSLER. *Ann. Phys., Lpz.*, **4** (*No.* 1–2) 90–1 (1948) *In German.*
See Abstr. 55 (1949).

539.152

**5189. An improved approximate analytic solution of the Thomas–Fermi equation for atoms** N. H. MARCH. Note in *Proc. Camb. Phil. Soc.*, **46** (*Pt* 2) 356–7 (1950).

539.152.1

**5190. A precise method of determining the Faraday by magnetic resonance.** J. A. HIPPLE, H. SOMMER AND H. A. THOMAS. Letter in *Phys. Rev.*, **76,** 1877–8 (*Dec.* 15, 1949).

The ratio of the cyclotron resonant frequency $\nu_c$ for the acceleration of protons, to the nuclear resonance frequency $\nu_n$, in the same magnetic field, was $\nu_c/\nu_n = 0{\cdot}358106 \pm 0{\cdot}000010$. The value of the Faraday was calculated from $F = \gamma M_p(\nu_c/\nu_n)$, where $\gamma$ is the proton gyromagnetic ratio, and $M_p$ is the proton isotopic weight, $F = 9\,652{\cdot}8 \pm 0{\cdot}8$ e.m.u./g. Using the measurements of Brown and Purcell

[Abstr. 6364 (1949)] the ratio of the proton mass $M_p$ to the electron mass $m_e$ was calculated, $M_p/m_e = 1\,835{\cdot}979 \pm 0{\cdot}056$. J. HUGHES

539.152.1

**5191. Spin-orbit coupling in the atomic nucleus.** H. GAUS. *Z. Naturforsch.*, **4a**, 721–3 (*Dec.*, 1949) *In German.*

Successful interpretations of the term schemes of atomic nuclei have been made by assuming a strong spin-orbit coupling. It is here shown that such a coupling is predicted by the vector meson theory, as a consequence of the interaction between the meson and nuclear fields. P. M. DAVIDSON

539.152.1

**5192. Rotational spectra of atomic nuclei.** P. PREISWERK. *Helv. Phys. Acta*, **23** (*No.* 1–2) 7–14 (1950) *In German.*

The nucleus is considered as a rigid spherically symmetrical body. It is shown that many nuclear energy levels can be classified as rotational levels of the nucleus behaving as a rigid rotator. A higher approximation is also considered in which the nucleus is elongated, the constants of the elongation being derived from the nuclear quadrupole moment.

J. HUGHES

539.152.1

**5193. Note on nuclear models.** H. LU. Letter in *Phys. Rev.*, **77**, 416 (*Feb.* 1, 1950).

It is shown that the proton-shell neutron-core nuclear model is successful in accounting for the nuclear radii of the $\alpha$-emitters, and the fast neutron scattering cross-section for medium weight nuclei.

J. HUGHES

539.152.1

**5194. Nuclear saturation for $V=\frac{1}{2}(1+P)J(r,\sigma_1,\sigma_2)$.** E. GERJUOY. Letter in *Phys. Rev.*, **77**, 568 (*Feb.* 13, 1950).

It is demonstrated that a nucleon interaction of this form [see Abstr. 2528 (1948)] is very unlikely to give saturation of heavy nuclei.

539.152.1

**5195. Nuclear energy levels in isotopes of potassium.** V. L. SAILOR. *Phys. Rev.*, **77**, 794–8 (*March* 15, 1950).

Targets made from the separated isotopes $K^{39}$ and $K^{41}$ were bombarded by 3·90 MeV deuterons, and protons from the nuclear reactions $K^{39}(d,p)K^{40}$ and $K^{41}(d,p)K^{42}$ were observed. The energy distribution of the protons emitted in each reaction was obtained by measuring the $p$ yield as a function of range. The ground state $Q$-value for $K^{39}(d,p)K^{40}$ was found to be $5{\cdot}48 \pm 0{\cdot}08$ MeV, giving the mass difference $K^{40} - K^{39} = 1{\cdot}00070 \pm 0{\cdot}00007$ mass units. Excited states of $K^{40}$ were found at 0·81, 2·01, 2·56, 3·3, 3·7, 4·2 and 4·8 MeV. The ground state $Q$-value for $K^{41}(d,p)K^{42}$ was $5{\cdot}12 \pm 0{\cdot}10$ MeV, giving the mass difference $K^{42} - K^{41} = 1{\cdot}00109 \pm 0{\cdot}00010$ mass units. Excited states of $K^{42}$ were found at 0·62, 1·18, 1·97 and 2·29 MeV. A.

539.152.1

**5196. Maximum mass numbers of stable nuclei.** J. TUTIN. Letter in *Nature, Lond.*, **165**, 442 (*March* 18, 1950).

539.1

**5197. Excited states of $Be^7$.** J. C. GROSSKRE AND K. B. MATHER. *Phys. Rev.*, **77**, 580–4 (*Marc* 1950).

Evidence for the existence of excited states of below 1 MeV has been found from a study of neutrons produced in the reaction $Li^7(p,n)$ Using a beam of homogeneous protons of 5 M energy from the Washington University cyclotr the neutrons were detected by a standard pho graphic plate method. In addition to the grou state group of neutrons, 3 additional lower ene groups were observed indicating an excited le structure for $Be^7$. 3 separate runs on 3 separ targets of varying thickness gave the same resu Observations were made at 20° and 90° to the proc beam for each target. In every case the shift energy of the peaks as one goes from 90° to 20 consistent with the assignment of definite levels $Be^7$. Values obtained for the level excitation energ are: $0{\cdot}205 \pm 0{\cdot}070$ MeV, $0{\cdot}470 \pm 0{\cdot}070$ MeV, $0{\cdot}745 \pm 0{\cdot}070$ MeV above the ground state. T level at 470 keV is presumably analogous to the w known level at 478 keV in the mirror nucleus $Li^7$. Levels in $Li^7$ corresponding to the other two lev found in $Be^7$ have as yet not been observed, and m of course, not exist. The $Q$ for the ground st reaction was found to be $-1{\cdot}65 \pm 0{\cdot}04$ MeV good agreement with previously obtained values.

539.15

**5198. Nuclear induction signals for long relaxati times.** E. E. SALPETER. *Proc. Phys. Soc., Lond.* **63**, 337–49 (*April*, 1950).

Equations of motion, previously derived by Blo [Abstr. 407 (1946)], for the nuclear magnetic mome in a nuclear induction experiment are applied to steady state reached when the strong magnetic fie $H_z$ is swept sinusoidally about its resonance valu Different approximations for the shapes and siz of nuclear induction signals are derived for vario limiting cases, depending (*a*) whether the passage $H_z$ is "adiabatic" or "extremely non-adiabatic" (ve weak radio-frequency field) and (*b*) whether t relaxation times are shorter or longer than the perio of the sweep of $H_z$. It is found that quite lar signals may be induced by even a very weak radi frequency field if the relaxation times are very long.

539.152

**5199. Statistical model for nuclear shells.** I IVANENKO AND V. RODICHEV. *Dokl. Akad. Nau SSSR*, **70** (*No.* 4) 605–8 (1950) *In Russian.*

Neutrons and protons form shells similar to electro shells of atoms. The sequence of their energy level is re-determined using Thomas–Fermi statistic The order of levels and shells differs from that o electron shells in so far as (1) the sequence of level in each shell is reversed, (2) the strict filling of shell is completed before a higher one begins to be filled Only the simplest nuclear forces were assumed, thei non-central character being ignored. J. JACOB

539.152.1 : 530.14

**On a new theory of nuclear forces.** *See Abstr.* 470

539.152.2

**On the magnetic moments of $Mn^{55}$, $Co^{59}$, $N^{15}$ and $N^{14}$.** W. G. PROCTOR AND F. C. YU. r in *Phys. Rev.*, **77**, 716–17 (*March* 1, 1950).

539.152.2

**The dependence of a nuclear magnetic ance frequency upon chemical compound.** W. G. TOR AND F. C. YU. Letter in *Phys. Rev.*, **77**, *March* 1, 1950).

e exact nuclear resonance frequency of $N^{14}$ is r in ammonium salts and urea than in nitrates. $NH_4NO_3$ the difference is 1·0 kc/s at 3 300 kc/s 00 gauss) and is proportional to the field. The rence is increased by the addition of paramagnetic up to 1·6 kc/s. These shifts are of the order of otal diamagnetic correction for free atoms.

D. H. WHIFFEN

539.152.2

**. Dependence of the $F^{19}$ nuclear resonance ion on chemical compound.** W. C. DICKINSON. r in *Phys. Rev.*, **77**, 736–7 (*March* 1, 1950).

ie exact external magnetic field for resonance in t 28·0 Mc/s (~ 7 000 gauss) is 1·05 gauss lower $C_2F_3Cl_3$ than for $BeF_2$, and is intermediate for HF, etc. Measurements at 10·0 Mc/s (2 500 s) show the separation to be ∝ the applied field.

D. H. WHIFFEN

539.153

**. Wave functions and transition probabilities he electrons of the Mg I-atom. I.** L. BIERMANN E. TREFFTZ. *Z. Astrophys.*, **26** (*No.* 2–3) 213–39 9) *In German.*

ave functions are calculated for $^1S(3s,3s)$, $s,3p)$, $^3P(3s,3p)$, $^3D(3s,3d)$ and $^3F(3s,4f)$, whereby is made of Fock's wave equations [*Z. Physik*, **61**, (1930)]. The first 5 sections deal with the ntum-theoretical foundations of the problem, the describes the technique of the extensive calcula-s, while the 7th summarizes all the numerical lts obtained. A. BEER

539.153

**. Wave functions and transition probabilities the electrons of the Mg I-atom. II.** E. TREFFTZ. *strophys.*, **26** (*No.* 2–3) 240–63 (1949) *In German.* ontinuation of preceding Abstr. States of Mg I now calculated, in which several electron con-rations participate. Firstly, the theory of the ence of the $(3p, 3p)^1D$ on the $(3s, nd)^1D$ terms is loped. Next, the influence of $(3p, 3p)^1S$ on the nd state is examined. In both cases the good ement of the calculated energy values with the rved terms is noted. Detailed treatment is her given to the influence on the oscillator ngths, with comparison with the numerical rvational results of Kersten and Ornstein str. 3113 (1947)]. A. BEER

539.153

**5. On the Lamb-shift and the ionisation energy helium-like atoms.** H. E. V. HÅKANSSON. *Ark.* , **1**, *Paper* 27, 555–7 (1950).

ethe's results for the level shift of hydrogen like ns can be generalized under certain conditions atoms with $n$ electrons. The radiative correction of the ionization energy of the He-like atoms in the ground state is established, and the average excitation energy for the ground state of H. J. JACOBS

539.153

**5206. Term values in the $f^3$ electron configuration.** V. RAMAKRISHNA RAO. Letter in *Curr. Sci.*, **19**, 8–9 (*Jan.*, 1950).

These are determined by wave-mechanical methods and compared with Racah's results [Abstr. 634 (1943)]. A few discrepancies occur, e.g. Racah had $^4F$ and $^4S$ equal, whereas now they are well separated as required by the different $l$ value. J. JACOBS

539.153

**5207. A simple method for evaluation of atomic and ionic ground states.** M. B. GOREN. *J. Opt. Soc. Amer.*, **40**, 74–5 (*Feb.*, 1950).

539.153 : 537.531.85

**5208. Momenta in atoms using the Thomas–Fermi method.** C. A. COULSON AND N. H. MARCH. *Proc. Phys. Soc., Lond. A*, **63**, 367–74 (*April*, 1950).

The Thomas–Fermi statistical theory of the free atom is used to calculate the momentum distribution and the shape of the Compton profile for X-ray scattering, the results being expressed in dimensionless form applicable to all atoms. The mean momentum, which varies as $Z^{2/3}$, where $Z$ is the atomic number, agrees well with more accurate wave-mechanical calculations. Numerical results are also reported for A and Kr using the Dirac modification of the original theory, in which exchange effects are taken into account and the atom has a finite radius. Agreement with experiment is not noticeably better with these refinements. A.

539.155.2

**5209. On a graphical systematic arrangement of the stable atomic nuclei.** F. L. BREUSCH. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **12**, 1–37 (*Jan.*, 1947) *In German.*

A new diagram of the stable nuclei is constructed with atomic number as abscissae, and inclined at 45° the neutron excess. The curves are discussed, and used to provide criteria for the existence of isotopes of even atomic number. J. HUGHES

539.155.2

**5210. The periodic law of atomic nuclei. The isotopes at the end of the periodic system.** A. P. ZNOIKO. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 2) 169–71 (1949) *In Russian.*

From the isotopic curves obtained by plotting $Z/A$ against $A$ [Abstr. 3331–2 (1950)] the possibility is demonstrated of forecasting nuclei of isotopes hitherto undiscovered and of estimating their ½-life period. The nuclei of 142 such isotopes are shown on the isotopic curves. Nuclei are postulated for elements 97, 98, 99, 100 with ½-life periods of the order of years, which indicates the possibility of isolating these isotopes for study. The most stable isotopes for elements 97–100 are $97^{247}$, $98^{250}$, $99^{251}$ and $100^{254}$. It is also possible to forecast the type of radiation and other properties of each nuclei. The most stable nuclei of Pu are $Pu^{242}$ and $Pu^{244}$, one of which is the "primary" nucleus. For At, Rn and Fr the most stable nuclei are not $At^{210}$, $Rn^{222}$ and $Fr^{223}$,

known at present, but $At^{209}$, $Rn^{212}$, $Fr^{213}$, which are also the "primary" isotopes of these elements.

W. HUGHES

539.155.2

**5211. The mass of $^4He$.** H. EWALD. *Z. Naturforsch.*, **5a** (*No.* 1) 1–5 (1950) *In German.*

Using a mass spectrograph, with a resolving power of ~40 000, the mass difference of the doublet $D_2$–He is found to be 25·604 ± 0·008 millimass units. The method of determining the inhomogeneity of the magnetic field, using the known lines C, CH, $CH_2$, $CH_3$, $CH_4$, $NH_3$, $H_2O$, is discussed in detail.

J. HUGHES

539.155.2

**5212. The isotopic constitution of scandium, gadolinium, dysprosium, holmium, erbium, and ytterbium.** W. T. LELAND. *Phys. Rev.*, **77**, 634–40 (*March* 1, 1950).

The relative abundances of these isotopes have been redetermined with a mass spectrometer incorporating an electron multiplier to give increased sensitivity. No new isotopes were found although special attention was devoted to this problem and low upper limits were set for nearly all possible isotopes. A.

539.155.2 : 536.65 : 536.63

**Difference between the thermal-caloric properties of heavy and light water.** *See Abstr.* 4932

## RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

**5213. Units of radioactivity.** L. F. CURTISS, R. D. EVANS, W. JOHNSON AND C. T. SEABORG. *Rev. Sci. Instrum.*, **21**, 94 (*Jan.*, 1950).

Recommendations of a committee of the National Research Council. This committee unanimously adopted the following definitions:—*curie.*—That quantity of any radioactive species (radioisotope) undergoing exactly $3·700 \times 10^{10}$ disintegrations per second. *rutherford.*—That quantity of any radioactive species (radioisotope) undergoing $10^6$ disintegrations per second. *r.h.m.*—For the quantitative comparison of radioactive sources emitting gamma-rays, for which disintegration rates cannot be determined, the roentgen per hour at one metre (r.h.m.) is recommended. A.

539.16.08

**5214. Radioactivity surveying and monitoring instruments.** D. TAYLOR. *J. Sci. Instrum.*, **27**, 81–8 (*April*, 1950).

Instruments which have been developed (for this purpose) and recent trends in design, are described. A.

539.16.08 : 537.542

**The behaviour of rectangular and square section transparent beta-counters.** *See Abstr.* 5056

539.162

**5215. On the calculation of the probability of nuclear disintegration by electron capture.** P. BENOIST-GUEUTAL. *C.R. Acad. Sci., Paris*, **230**, 624–6 (*Feb.* 1950) *In French.*

In the event of *K*-capture, the remaining ex nuclear electrons must all move out a little. effect this has on the mean life is discussed, evaluated in detail for the case of $_4Be^7$. E. P. GEO

539.

**5216. Probabilities of beta decay and orb electron capture for the forbidden transitions.** NAKAMURA, S. SIMA AND M. KOBAYASI. *J. Ph Soc. Japan*, **4**, 166–71 (*May–June*, 1949).

Total probabilities for $\beta$ decay and orbital electr capture are calculated according to Fermi theory the case of the first and the second forbidden tra tions. In this case, the ratio of the probabilities s the positron emission to those for the *K*-elect capture are also estimated as a function of nuclear charge and radius.

539.162 : 539.

**5217. The β-stability of heavy nuclei.** S. NOR STRÖM. *Z. Naturforsch.*, **5a** (*No.* 1) 6–8 (1950) *German.*

Stability rules for $\beta$-decay are suggested, a applied to nuclei emitting α-particles to determ which decay purely by α-emission, and which ha dual decay. J. HUGH

539.1

**5218. The electrical charge of 18-min. $Br^{80}$ fr isomeric transition.** S. WEXLER AND T. H. DAVI *J. Chem. Phys.*, **18**, 376–8 (*March*, 1950).

The space between two concentric Cu-amalga electrodes was filled to several microns pressure wi $C_2H_5Br$ containing 4·4 hr $Br^{80*}$. The distributi between electrode surfaces of 18 min $Br^{80}$ dissociat from $C_2H_5Br$ in consequence of the isomeric trans tion process was determined. The results establi the presence of positively charged 18 min Br species among the decay products. At least 50% the dissociations yield positive $Br^{80}$ species. T remainder yield uncharged $Br^{80}$ species.

539.16

**5219. A possible isomeric state of RaE.** H. N NEUMANN, J. J. HOWLAND, JR. AND I. PERLMA Letter in *Phys. Rev.*, **77**, 720–1 (*March* 1, 1950).

539.16

**5220. Low mass francium and emanation isotopes high alpha-stability.** E. K. HYDE, A. GHIORSO AN G. T. SEABORG. *Phys. Rev.*, **77**, 765–70 (*March* 1 1950).

Isotopes of Fr with 126 or fewer neutrons ha been looked for in bombardments of $Th^{232}$ wit 350 MeV protons from the 184 in cyclotron. $Fr^{21}$ with an apparent ½-life of 19·3 min for branchin decay by α-emission (44%) to $At^{208}$ and by orbita electron-capture (56%) to $Em^{212}$, has been found $Em^{212}$ is shown to be a 23 min α-emitter. $At^{20}$ decays primarily (99·5%) by orbital electron-capture to $Po^{208}$, but shows 0·5% α-branching. The Fr an emanation isotopes have α-half-lives completely a variance with the simple predictions based on th previously known isotopes of these elements. Thei high α-stability is believed to be due to a closed shel of 126 neutrons in analogy to the behaviour o elements 83–85. The non-existence of long-lived F

iature is discussed in the terms of this and other nt work on Fr isotopes. A.

539.163

**1. Disintegration of $Te^{121}$ and $Te^{123}$ isomers.** Katz, R. D. Hill and M. Goldhaber. *Phys. ., 78,* 9–11 (*April* 1, 1950).

Line intensities in the conversion electron spectra $Te^{121}$ and $Te^{123}$ were evaluated in a variable field, 0° focusing $\beta$-ray spectrograph. Electron-electron incidences were obtained between the transition rs 82–213 keV in $Te^{121}$ and 88·5–159 keV in $Te^{123}$. cay schemes for the two isomers are shown. A.

539.163 : 614.8

**Radioactive waste disposal.** *See Abstr.* 5401

539.163.1

**2. Half-life for double beta-decay.** C. A. Vine, A. Ghiorso and G. T. Seaborg. Letter in *ys. Rev.*, 77, 296 (*Jan.* 15, 1950).

The presence of $Pu^{238}$ in $U^{238}$ would require double decay of the latter, since the intermediate $Np^{238}$ is avier than both. 14 kg of very pure 6 yr old $UO_3$ s subjected to a chemical process for Pu extraction d a search was then made for the 5·51 MeV, $^{238}$ $\alpha$-particles, with negative results. This indicates t the $\frac{1}{2}$-life of $U^{238}$ for the double $\beta$-emission is $6\times10^{18}$ yr. L. R. Shepherd

539.163.1

**3. The half-life of carbon fourteen and a comison of gas phase counter methods.** W. W. Miller, Ballentine, W. Bernstein, L. Friedman, A. O. er and R. D. Evans. Letter in *Phys. Rev.*, 77, 4–15 (*March* 1, 1950).

539.163.1 : 539.172.11

**4. Neutron-deficient cesium isotopes.** R. W. nk, F. L. Reynolds and D. H. Templeton. *ys. Rev.*, 77, 614–16 (*March* 1, 1950).

The new isotopes $Cs^{127}$ and $Cs^{129}$ have been proced from I by irradiation with high energy He ions. eir mass assignments were determined with a mass ectrograph. $Cs^{127}$ decays with $5·5 \pm 0·5$ hr ife with emission of positrons (1·2 MeV maximum ergy), giving rise to the daughter activity 34-day $^{127}$. $Cs^{129}$ decays by electron capture with $\frac{1}{2}$-life $\pm$ 1 hr. A 30 min activity, presumed to be $Cs^{130}$, is also produced, but its mass assignment is certain. A.

539.164 : 537.534.75

**5. The range-energy curves for alpha-particles d protons.** W. P. Jesse and J. Sadauskis. *Phys. ev.*, 78, 1–8 (*April* 1, 1950).

Previous experiments have shown that in A there ists a very good proportionality between the ergy of an $\alpha$-particle and the total ionization oduced by it. In air this proportionality is not und, the ionization decreasing more rapidly than ergy at low $\alpha$-energies. Range-energy curves termined in the region 0–5 MeV, where the ionizaon in air is used as a measure of the $\alpha$-energy, hence ve too low energy values. Such curves, when rrected to equivalent ionization values in A, show uch better agreement with range and energy data rived from nuclear reactions. The range-energy rve for protons, derived from the $\alpha$-curve, also ows improved agreement with nuclear data when the corrected $\alpha$-range-energy curve is substituted for the old. A.

539.164 : 537.534.75 : 778.3

**5226. Range-energy relation for protons and alpha particles in photographic emulsions for nuclear research.** J. Rotblat. *Nature, Lond.*, **165,** 387–8 (*March* 11, 1950).

The range-energy relationship for protons and alpha-particles for energies between 0 and 8 MeV was determined in Ilford C2, E1, and G5, and Kodak NT2a plates. The particles were produced by passing a deuteron beam from a cyclotron through a chamber filled with H or He. The plate was placed in the chamber such that the particles entered the emulsion at an angle of dip of between 6 and 10°, the angle of scattering of the particles being between 20 and 160°. Check points were also obtained with the known alpha-particles of polonium and thorium C and C′. The values obtained agree well with those by Fowler, Lattes and Cüer [Abstr. 2967 (1947)] at the higher energies, with small discrepancies for lower energies. There were small differences between the various emulsions tested. W. F. Berg

539.164.9 : 541.14

**Radiochemical yield of the ultra-violet emission in a gas traversed by $\alpha$-particles.** *See Abstr.* 5383

539.165

**5227. Characteristics of positron discharge.** M. A. Levitskaya and L. P. Rapoport. *Dokl. Akad. Nauk, SSSR,* **70** (*No.* 5) 817–20 (1950) *In Russian.*

Fermi's theory does not distinguish between positron $\beta^+$ and electron $\beta$-emission, but experimental evidence indicates certain characteristics of $\beta^+$ discharge which distinguishes it from $\beta$-emission. These characteristics in the main are connected with the position of the emitting nucleus with respect to the first stable isotope with the same atomic no. $Z$, and with its position in the system of nuclei. In order to distinguish any regularities a graph is drawn of the log of the $\frac{1}{2}$-life of positron active nuclei against $Z$, each positron active nucleus being labelled with the no. of neutrons which it requires to bring it up to the first stable isotope with the same $Z$. The graph shows above all that light nuclei up to $Z = 22$ have, almost exclusively, short $\frac{1}{2}$-life periods. Short life periods are also abundant for $Z = 29$–35, 41–43, 47–51 and at 59, 66, 68 and 75. All positions above $Z = 22$ lie in the region of special zones. The nearer the positron active nucleus to the first stable isotope the greater the $\frac{1}{2}$-life period; this is also true to a lesser extent for electron active nuclei. Other conclusions are drawn which seem to confirm the existence of special zones and the possible periodicity connected with them. W. Hughes

539.165

**5228. Determination of the maximum energy of beta-rays from Cu62 by a new method of analyzing absorption data.** L. Katz, A. S. Penfold, H. J. Moody, R. N. H. Haslam and H. E. Johns. Letter in *Phys. Rev.*, 77, 289–90 (*Jan.* 15, 1950).

Utilizes an extension of a method for analysing Al absorption curves, originally due to Widdowson and Champion [*Proc. Phys. Soc., Lond.*, **50,** 185 (1938)]. The lower part of the absorption curve is

assumed to take the form $y = K(E_0 - E)^n$, where $y$ is the fractional transmission (after subtracting $\gamma$-background), $E_0$ the end-point energy and $E$ the energy of particles just absorbed with the given thickness of Al. $E_0$ and $n$ are determined by a method of successive approximations starting with a rough value of $E_0$ and plotting $\log y$ *v.* $\log(E_0 - E)$ and $y^{1/n}$ *v.* $E$. $Cu^{62}$ was obtained by 22 MeV betatron irradiation of Cu and a mean value of $2{\cdot}92 \pm 0{\cdot}06$ MeV was obtained for the end-point energy.

L. R. SHEPHERD

539.165

**5229. A note on the relative selection rules of forbidden β-ray transitions.** R. Nataf. *C.R. Acad. Sci., Paris*, **230**, 532–4 (*Feb.* 6, 1950) *In French.*

The calculations of Marshak [Abstr. 1867 (1942)] of the transition probabilities in $\beta$-decay are repeated, neglecting relativistic corrections and non-central forces. Much simpler transition probabilities are obtained, and the effect on their interpretation of introducing relativistic corrections discussed.

J. HUGHES

539.165

**5230. The beta-ray distribution of $Tc^{99}$.** B. H. Ketelle and J. W. Ruch. Letter in *Phys. Rev.*, **77**, 565–6 (*Feb.* 15, 1950).

539.165

**5231. The radiations of praseodymium-142.** E. R. Rae. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 292–3 (*March*, 1950).

Pile irradiated $Pr_2O_3$ was examined in a 12 cm radius semicircular magnetic spectrometer of 2% resolution. Two components were observed in the $\beta$-spectrum with end-points $2{\cdot}23 \pm 0{\cdot}04$ MeV and $0{\cdot}66 \pm 0{\cdot}02$ MeV in the intensity ratios 4 : 1. In addition a weak conversion line was found to be present due to a transition of energy of $0{\cdot}135 \pm 0{\cdot}005$ MeV. The secondary electron spectrum from a Cu container and Pb radiator revealed a hard $\gamma$-ray of energy $1{\cdot}59 \pm 0{\cdot}04$ MeV. It is suggested that the 2·23 MeV $\beta$-decay is to the ground state of $Nd^{142}$.

L. R. SHEPHERD

539.165

**5232. The beta-spectra of $Cs^{137}$, $Y^{91}$, $Pm^{147}$, $Ru^{106}$, $Sm^{151}$, $P^{32}$, and $Tm^{170}$.** H. M. Agnew. *Phys. Rev.*, **77**, 655–60 (*March* 1, 1950).

These have been investigated using a large double-magnetic lens spectrometer. The investigation of these materials was carried out with sources whose thicknesses were $< 0{\cdot}1$ mg/cm². The sources were mounted on thin foils in such a manner that they did not accumulate charge. $Cs^{137}$ and $Y^{91}$ were found to have distinctly non-linear Fermi plots. $Ru^{106}$, $Pm^{147}$ and $Sm^{151}$ have linear Fermi plots, and the Fermi plot of $Tm^{170}$ is slightly curved. $P^{32}$ had an unusual Fermi plot at the low energy end. Auger electrons have been found associated with the $Ba^{137}$ decay product of $Cs^{137}$, and the internal conversion electrons have been found accompanying the continuous $\beta$-radiation from $Tm^{170}$. The energy of the $\gamma$-ray giving rise to the $Yb^{170}$ conversion electrons is $85{\cdot}4 \pm 0{\cdot}6$ keV. The end points of the continuous $\beta$-spectra of these materials have been determined as follows: Low energy group of $Cs^{137}$, $0{\cdot}523 \pm 0{\cdot}004$ MeV; $Y^{91}$, $1{\cdot}56 \pm 0{\cdot}010$ MeV; $Tm^{170}$, 0·990 ± 0·007 MeV; $Sm^{151}$, $0{\cdot}0755 \pm 0{\cdot}0010$ MeV; P[illegible] $1{\cdot}718 \pm 0{\cdot}01$ MeV; $Pm^{147}$, $0{\cdot}229 \pm 0{\cdot}001$ MeV; $Ru^{106}$, $0{\cdot}0392 \pm 0{\cdot}0003$ MeV.

539.16

**5233. Low energy beta-ray spectra: $Pm^{147}$, $S^{35}$.** L. M. Langer, J. W. Motz and H. C. Price, Jr. *Phys. Rev.*, **77**, 798–805 (*March* 15, 1950).

These have been measured in order to study further the nature of any low energy deviation from the Fermi theory of $\beta$-decay. Measurements were made with thin, relatively uniform sources in both the 40 cm radius of curvature spectrometer and also in a small 180 deg. focusing Helmholtz coil spectrometer designed specifically for low energy spectra. The thinnest sources were less than 10 $\mu$g/cm². Using Zapon counter windows ranging from 15 to 3 $\mu$g/cm² and also a windowless counter technique Fermi plots were obtained which showed how the measured distribution of particles at low energy depends on both source and counter window thickness. Favourable experimental conditions yielded a straight line Fermi plot for $Pm^{147}$ above 8 keV. Less favourable conditions resulted in a straight line plot for $S^{35}$ down to at least 50 keV. Thus, $S^{35}$, which is allowed, and $Pm^{147}$, which is probably once forbidden, are found to have spectra of the allowed shape. It is concluded that under very favourable experimental conditions there is probably no real disagreement between the observed momentum distribution and that predicted for an allowed transition by the Fermi theory. On the basis of an improved calibration, the following end points are obtained: $Pm^{147}$, $223{\cdot}2 \pm 0{\cdot}5$ keV, and $S^{35}$, $167{\cdot}0 \pm 0{\cdot}5$ keV.

A.

539.165

**5234. β-spectrum of $Ho^{166}$.** N. M. Antoneva, A. A. Bashilov, B. S. Dzhelepov and A. V. Zolotavin. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 3) 397–400 (1950) *In Russian.*

The shape of this spectrum suggests a continuous $\beta$-spectrum with energy limit 1·84 MeV and an intensive group of slow electrons of energy $< 0{\cdot}1$ MeV. The deviation from a linear Fermi-diagram suggests the $\beta$-spectrum is complex, with an intensity ratio 1 : 6 of soft and hard components. The ratio of $L$–$M$ electrons to $\beta$-particles is rather greater than 1; this might imply an isomeric conversion, but exact measurements of the $K$ and $L$ intervals are not yet possible.

J. JACOBS

539.165

**5235. β-spectrum $Lu^{177}$.** N. M. Antoneva, A. A. Bashilov, B. S. Dzhelepov and A. V. Zolotavin. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 4) 597–9 (1950) *In Russian.*

If Lu is irradiated with slow neutrons new radioactive isotopes are formed with a $\frac{1}{2}$-life of 3·67 hr and 6–7 d. Mass-spectral analysis shows that the 6–7 d period is connected with $Lu^{177}$. Energy measurements are in agreement with earlier, less accurate, experimental determinations. Bethe reports X-ray emission during capture of $K$-electrons by $Lu^{177}$ nuclei; this seems unlikely as $Yb^{177}$ nuclei would be formed which in turn decay into $Lu^{177}$.

J. JACOBS

539.165

**5. On the $Ho^{166}$ disintegration.** K. SIEGBAHN H. SLÄTIS. *Ark. Fys.*, **1**, *Paper* 28, 559–62 (1950). high transmission $\beta$-spectrometer study on pile-diated Ho confirms earlier results of Grant and [Abstr. 3413 (1949)]. The $\beta$-spectrum is com- with k.e. end-points of 1·84 and 0·55 MeV. L and *M* conversion electrons due to an 80 keV sition are present and the lifetime of this state found to be $< 3\times10^{-7}$ sec by coincidence riments. The transition is 3·2% *K*-converted 20% *L*-converted and is probably an electric drupole-magnetic dipole transition. The spectrum econdary electrons from a 0·03 mm Pb radiator reveals a hard $\gamma$-radiation of $1{\cdot}36 \pm 0{\cdot}01$ MeV. lecay scheme is suggested with 11% of the $\beta$-ntegrations going to the 1·36 MeV level and the lainder direct to the 80 keV level.

L. R. SHEPHERD

539.165

**7. Radioactivity of potassium.** F. W. SPIERS. er in *Nature, Lond.*, **165**, 356 (*March* 4, 1950). he specific $\gamma$-ray activity was found to be quanta/sec/gm by an ionization chamber com- son with standardized sources of $Na^{24}$ and pitch-ide. The specific $\beta$-activity was found to be 5 $\beta$/sec/gm by a counter comparison with $Na^{24}$. a these are in agreement with previous work str. 182 (1948), 6399 (1949)].

B. ROSE

539.165 : 537.542

**as phase counting of low energy beta-emitters.** *Abstr.* 5057

539.165.2

**3. On the β-ray spectrum of potassium.** RANCHETTI AND M. GIOVANNOZZI. *Atti Accad. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **1**, 1078–87 *t.* 1, 1946) *In Italian.*

new end-point of the spectrum at $(1{\cdot}7 \pm \times10^6$ eV is found recording 1 000 tracks of trons, from $K^{40}$ disintegration, in a cloud chamber lackett's type with magnetic field of 450 oersted.

G. RIGHINI

539.165.2

**). The β-spectrum of $Be^{10}$.** D. J. HUGHES, EGGLER AND D. E. ALBURGER. Letter in *Phys.*, **77**, 726–7 (*March* 1, 1950).

539.166

**). On the internal conversion in *M*-shell and the ier analysis.** M. TANIHUJI. *J. Phys. Soc. Japan*, 07–11 (*March–April*, 1949).

he ratio $\alpha_M/\alpha_K$ ($\alpha_M$ = internal conversion ficient of $\gamma$-ray in *M* shell, $\alpha_K$ = int. conv. coeff. shell) is calc. and compared with exp. Agreement ot very satisfactory, due to the approximations le. The ratio $\alpha_M/\alpha_K$ is more sensitive than $\alpha_K$ to the value of spin change, *l*, between the ted and ground states of the isomeric nucleus.

A. O. STANESBY

539.166

**1. The structure of the γ lines of RaC.** A. A. HILOV, N. M. ANTONEVA AND A. V. ZOLOTAVIN. *l. Akad. Nauk, SSSR*, **70** (*No.* 5) 793–6 (1950) *Russian.*

atyshev and co-workers [Abstr. 7252–3 (1949), 3371 (1950)], during an investigation of the $\beta$-spectrum of RaC, established that the lines of electronic curves of $\gamma$-radiation with $h\nu$ = 606, 1 120, 1 238, 1 414, 1 760 and 2 200 keV were considerably wider than was expected, and also established the presence of a series of very narrow peaks superimposed on the basic line. They interpreted these results as being due to the fine structure of the $\gamma$-lines. Work carried out by the present authors on the $\beta$-spectrum of RaC with a spectrometer having a much better resolving power and under conditions such that the line is not distorted by the walls of the glass ampoules did not confirm Latyshev's results. The $\gamma$-lines of RaC for $h\nu$ = 606, 1 120, 1 414 and 1 760 were studied using an active precipitate of EmRa on an aluminium foil ($\sim 5\ \mu$) as a source. The lines obtained were considerably narrower than those of Latyshev. The values of $K/\beta$—the ratio of the height of the line to the height of the continuous spectrum under it were found to be 1·7, 1·2, 3·25 and 0·85 for $K$ = 606, 1 120, 1 414 and 1 760 respectively, Latyshev's corresponding values being 0·14, 0·3, 1·2, 0·2.

W. HUGHES

539.166

**5242. Measurement of some weak γ-ray intensities.** G. R. BISHOP, R. WILSON AND H. HALBAN. Letter in *Phys. Rev.*, **77**, 416–17 (*Feb.* 1, 1950).

Measurements were made by counting protons from the photodisintegration of D in an ionization chamber, using 2·62 MeV RdTh for energy calibration. $\gamma$-radiations of 3·05 and 3·35 MeV (intensities $\sim 0{\cdot}0013$ and 0·0003 respectively) were found in $Ga^{72}$; 2·55 and 2·9 MeV in $La^{140}$ (intensities $\sim 0{\cdot}04$ and 0·001), and 2·7 and 3·0 MeV in $Mn^{56}$ ($\sim 0{\cdot}001$ and 0·002 respectively). $\gamma$-rays of 2·89, 3·13 and 3·2 MeV in ThC″, 3·0 MeV in RaC′, 4·0 MeV in RaC″ and 4·14 MeV in $Na^{24}$ could not be detected.

L. R. SHEPHERD

539.166

**5243. Additional electron lines from radioactive europium.** J. M. CORK, H. B. KELLER, W. C. RUTLEDGE AND A. E. STODDARD. Letter in *Phys. Rev.*, **77**, 848–9 (*March* 15, 1950).

539.166

**5244. Angular correlation of successive internal conversion electrons.** H. FRAUENFELDER, M. WALTER AND W. ZÜNTI. Letter in *Phys. Rev.*, **77**, 557–8 (*Feb.* 15, 1950).

539.166

**5245. Internal conversion in $Ni^{60}$.** M. DEUTSCH AND K. SIEGBAHN. *Phys. Rev.*, **77**, 680–1 (*March* 1, 1950).

The coefficients of internal conversion for the two $\gamma$-rays accompanying the decay of $Co^{60}$ have been measured. For the 1·17 MeV $\gamma$-ray $\alpha = 2{\cdot}3\times10^{-4}$, for the 1·33 MeV ray $\alpha = 1{\cdot}8\times10^{-4}$. Comparison with theoretical values indicates that the parity change must be the same in both transitions and that the two $\gamma$-rays are probably electric quadrupoles. A.

539.166

**5246. Recoil electron spectrum of the $K^{40}$ gamma-ray.** R. W. PRINGLE, S. STANDIL AND K. I. ROULSTON. Letter in *Phys. Rev.*, **77**, 841 (*March* 15, 1950).

539.166

**5247. Polarization of annihilated γ-quanta.** N. A. VLASOV AND B. S. DZHELEPOV. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 777–9 (1949) *In Russian.*

An apparatus used for studying the polarization of annihilated γ-quanta is described schematically. It consists essentially of a positron source ($Cu^{64}$) contained in a metallic foil placed inside a Pb block having two conical canals with apices at the centre of the block, and which diverge on to opposite sides of the block. Two Al scatterers of conical shape are fixed outside the block and at a small distance from them, approx. perpendicular to the axis, banks of Bi counters are fixed, each bank consisting of 6 counters. The axes of all the counters are coplanar. The banks are arranged so that the scattered quanta pass, as far as possible, through all the counters. Both banks rotate around the canal axis so that the number of coincidences can be measured for different counter positions. All counter positions can be grouped into two main types, one in which the directions from the Al scatterers to counters are coplanar and the other where the directions are perpendicular. Two series of measurements were made, in the first the distance from the axis of the scatterer to the nearest counter was 5 cm while in the second the distance was 3·5 cm. Series I had somewhat better geometric properties and a source of greater intensity was used. Background was calculated on the basis of separate experiments. The ratio of true coincidences in the perpendicular direction to the coplanar direction was found to be $1{\cdot}7 \pm 0{\cdot}2$ in the first series and $1{\cdot}6 \pm 0{\cdot}2$ in the second series. It is considered that although these results cannot be compared quantitatively with the theoretical results, nevertheless it seems established that polarization of annihilated quanta in mutually perpendicular directions is in any case most probable, if not the only possible mode of polarization. W. HUGHES

539.166 : 537.542

**A sensitive directional gamma-ray detector.** *See Abstr.* 5060

539.166 : 539.172.4

**5248. Experiments on the measurement of the energy of γ-rays emitted during capture of neutrons.** M. L. ALEXANDROVA. *Dokl. Akad. Nauk, SSSR*, **69** (*No.* 6) 763–5 (1949) *In Russian.*

The energy of the γ-rays emitted during the reaction Cd $(n, \gamma)$ was measured by using thick photographic plates, the emulsion of which contained $D_2O$. The energy of the γ-quanta was measured by the proton tracks due to D fission. D is introduced into the emulsion by soaking the plates (previously heated to a high temperature) in $D_2O$, the subsequent drying being carried out under normal conditions. In this way plates containing from 3–12% $D_2O$ were prepared by varying the conditions. Plates treated in the same way but soaked in $H_2O$ were used for control experiments. A curve is plotted of $R$ the track length (in $\mu$) along one abscissa, with the corresponding energy of the γ-quanta along a parallel abscissa, against the number of protons with track lengths $R + \Delta R$ on the ordinate. $\Delta R \simeq 4\,\mu$, the probable error in determining $R$. A maximum is observed at $R = 51\,\mu$, the corresponding γ-quanta energy being 6·5 MeV. The form of the curve indicates that the most probable transition of the excited nucleus w be the transition into the fundamental state or o near to it. Slow neutrons are known to be captur only by $Cd^{113}$ so that the γ-radiation measur refers to $Cd^{114}$. W. HUGH

539.166 : 539.17

**5249. Neutron capture gamma-rays from $Be^9$, C and $N^{14}$.** B. B. KINSEY, G. A. BARTHOLOMEW AN W. H. WALKER. Letter in *Phys. Rev.*, **77**, 723 (*March* 1, 1950).

539.166 : 614

**5250. Concrete as a protective barrier for gamm rays from cobalt-60.** R. J. KENNEDY, H. O. WYCKO AND W. A. SNYDER. *J. Res. Nat. Bur. Stand., Was* **44**, 157–62 (*Feb.*, 1950).

The broad-beam and narrow-beam attenuation Co$^{60}$ γ-rays has been investigated experimentall and the data are presented here. In protecti barriers the geometry necessarily requires the use broad-beam attenuation curves to determine t required barrier thickness. This paper presen attenuation curves for Pb, concrete and steel nece sary for determining the required protection for a particular cobalt source in storage or transportatio There is also included a table for shielding requir ments for Co$^{60}$ sources of 10 millicuries to 2 curies.

539.166.0

**5251. Measurements of γ-ray energies by the ant coincidence counting method.** S. NAKAGAWA. *J. Sc Res. Inst., Tokyo*, **43**, 1–17 (*Jan.*, 1949).

γ-ray energies were determined by Al absorptic of Compton electrons ejected in the forward directio from thin Al. Under these circumstances the absor tion curve for a single γ-ray energy is a straight lin and it is possible to resolve several compone γ-radiations. The experimental arrangement co sisted of three thin (0·1 mm) wall Al β-counter set up with axes parallel to one another, coplana and perpendicular to the direction of the incide γ-rays. The counter nearest the source was set u in anticoincidence with the second counter, which i turn was in coincidence with the farthest counte This ensured that only those electrons originating i the thin adjacent walls of counters 1 and 2 an passing through 2 and 3 were recorded. A slit syste between counters 2 and 3 limited the electron recorded to within an angle of 20°–35° of the incide γ-ray direction. The Al absorbers were place between the coincident counters. The compone straight lines of the absorption curves were extra polated to the axis to give "practical maximu ranges." A practical maximum range-energy relatio for monokinetic electrons, given by Vardar, wa confirmed by observations on the 1·78 and 2·2 Me Ra γ-rays. The method was used to measure th energy of γ-rays evolved in slow neutron capture b H, Cl, Ti, Cr, Mn, Fe, Ni, Cu, Zn, As, Br, Ag an Cd, and the resulting γ-ray energies are tabulated.

L. R. SHEPHERI

539.166.08 : 578.088

**5252. The quantitative determination of gamm radiation in biological research.** R. F. HILL, G. J HINE AND L. D. MARINELLI. *Amer. J. Roentgenol Radium Ther.*, **63**, 160–9 (*Feb.*, 1950).

$I^{131}$ has been used to illustrate the physical proble

lved in the *in vitro* and *in vivo* measurement of diation. Apparatus for achieving $2\pi$ and $4\pi$ metry in the measurement of liquid samples has shown. Improvements in the technique em- ed for *in vivo* measurement consist of Pb shielding plugs. An apparatus combining these features the calibration of this apparatus for quantitative vith the thyroid gland have been described. A.

539.166.74

**. Simultaneity in the Compton effect.** R. HOF- TER AND J. A. MCINTYRE. *Phys. Rev.*, **78**, 24–8 *il* 1, 1950).

he Bothe–Geiger experiment has been repeated r improved conditions of time resolution, ined by using stilbene scintillation counters. recoil electron and scattered photon are emitted ther within a time interval of $< 1{\cdot}5\times10^{-8}$ sec. electron and photon are also projected with a y $< 1{\cdot}5\times10^{-8}$ sec after arrival of a quantum. familiar concepts used in discussions of the apton effect are shown to be valid. A.

539.166.74 : 537.531.85

**. Higher approximations to the Klein–Nishina ula by the theory of radiation.** M. R. SCHAFROTH. *. E.T.H. Zürich*, 35 *pp.* (1949) *In German.*

Lorentz- and gauge-invariant matrix element for $e^6$-approximation of the Compton effect is ined by parallel calculations in co-ordinate and mentum space. The effective cross-section is uated only for small energies, and the assumptions ired for the calculation with divergent expressions liscussed in detail. The analogous problem of the ering of light by Bose-particles has been studied Corinaldesi and Jost [Abstr. 4014 (1949)].

P. T. LANDSBERG

## NUCLEAR REACTIONS 539.17

539.17

**. The isolation of actinium.** F. HAGEMANN. *mer. Chem. Soc.*, **72**, 768–71 (*Feb.*, 1950).

illigram quantities of Ac, produced by trans- ation of Ra with pile neutrons, have been isolated the first time in the form of essentially pure pound. A.

539.172

**. Remarks on the nuclear disintegration by m capture.** Y. FUJIMOTO, S. HAYAKAWA AND YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **4**, 6 (*Oct.–Dec.*, 1949).

uclear disintegrations arising from the capture of meson are briefly discussed, and the correspond- lisintegrations arising from $\tau^-$ meson capture are idered on the assumption of a capture process the end product $\tau^- + P \rightarrow P + \pi^-$, or $N + \pi^0$. *K* state of $\tau^-$ capture may be so far embedded in nucleus that capture by a central proton is likely, produced $\pi^-$ meson then having small prob- ty of emerging with the full energy of the initial ess. J. G. WILSON

539.172

**5257. Nuclear disintegration by $\pi^-$ meson capture.** Y. FUJIMOTO, S. HAYAKAWA AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **4**, 576–7 (*Oct.–Dec.*, 1949).

Disintegration following $\pi^-$ capture is treated (*a*) assuming two nucleons to be directly excited, (*b*) as in (*a*) but considering the transparency of nuclear matter (*c*) assuming interaction directly with many nucleons. All models yield results in reasonable agreement with experiment. J. G. WILSON

539.172

**5258. An improved nuclear disintegration camera.** J. H. SANDERS. *J. Sci. Instrum.*, **27**, 100–1 (*April*, 1950).

A method is described of using photographic plates for the accurate measurement of the yield and angular distribution of fast-ionizing particles from a target bombarded by an ion beam, even when the total yield is low. The error due to a small displacement of the beam is largely compensated by the use of two parallel plates, so that it is possible to evaluate the track density to about 1% without introducing any inaccuracy comparable with the statistical error. The construction of a gas target camera using this principle is shown. A.

539.172

**5259. Reactions leading to $Fe^{53}$, $Mn^{57}$, and $Cr^{55}$.** M. E. NELSON AND M. L. POOL. *Phys. Rev.*, **77**, 682–3 (*March* 1, 1950).

An end point corresponding to an energy of $2{\cdot}8 \pm 0{\cdot}1$ MeV has been determined for the $Fe^{53}$ 8·9 min positron activity. $(\alpha, p)$ and $(n, p)$ reactions on enriched $Cr^{54}$ and $Fe^{57}$ respectively failed to produce any activity in $Mn^{57}$. The previously reported 1·3 to 2·3 hr activity of $Cr^{55}$ was shown not to be produced by a $(d, p)$ reaction on enriched $Cr^{54}$ nor by an $(n, \alpha)$ reaction on enriched $Fe^{58}$. The 3·9 min $V^{52}$ activity is readily produced by a $Cr(d, \alpha)$ reaction, using Cr enriched in isotope 54. A.

539.172 : 537.591.8

**Showers of minimum ionizing particles from cosmic-ray induced nuclear disintegrations.** *See Abstr.* 5109

539.172 : 539.18

**5260. Stars in photographic emulsions initiated by $\pi$ mesons.** F. L. ADELMAN AND S. B. JONES. *Science*, **111**, 226–9 (*March* 3, 1950).

Star formation by 512 artificial $\pi^-$ mesons stopping in Ilford C.2 emulsion was studied. 27% produce no observable star, and of stars those with two prongs, which may include a nuclear recoil, are most abundant. The average number of prongs per meson is 1·7. Further measurements in electron-sensitive emulsions show no emitted protons of energy $> 40$ MeV. J. G. WILSON

539.172 : 541.14

**Exchange reactions in $(n, \gamma)$ nuclear transformations.** *See Abstr.* 5384

539.172.13

**5261. Investigation of the energy of protons formed during the bombardment of fluorine and sodium by deuterons.** YU. A. NEMILOV AND L. I. GEDEONOV. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 2) 219–20 (1950) *In Russian.*

Targets made by precipitating a suspension of

$CaF_2$ in acetone on to Pt foil, and of $Na_2CO_3$, NaBr and NaI respectively on Pt foil were bombarded by 3·9 MeV deuterons. The protons thus formed were registered on photographic plates before which were placed Al filters in the form of a wedge with a thickness ≡ 2–60 cm of air. The degree of darkening corresponding to groups of particles of different energies was observed as before [Abstr. 1985 (1950) and *Dokl. Akad. Nauk*, **66**, 369 (1949)]. From the results obtained for F targets it is postulated that the first group of protons corresponds to the formation of unexcited $F^{20}$ from $F^{19}$ in the reaction $F^{19}(d, p)F^{20}$ while the next 4 groups correspond to the formation of $F^{20}$ of different degrees of excitation by the same reaction. Using the reaction energies found and the most recent data for the mass of $F^{19}$ and the proton respectively, the mass of $F^{20}$ is calculated as 20·0064 ± 0·0010. The first 3 groups of protons obtained during the bombardment of Na targets are probably obtained from the reaction $Na^{23}(d, p)Na^{24}$ and the value for the mass of $Na^{20}$ calculated accordingly is 23·9964 ± 0·0008. The remaining two proton groups are probably from the reaction $O^{16}(d, p)O^{17}$. The values of the reaction energy are in good agreement with the accepted values for the mass of the O isotope. W. HUGHES

539.172.13

**5262. On the phenomenon of the peculiar activities produced by deuterons in silver.** C. CHAMIÉ. *J. Phys. Radium*, **11**, 77–9 (*Feb.*, 1950) *In French.*

Continuation of previous work [Abstr. 1208–9 (1950)]. The excitation functions of the activities were measured. The peculiar activity shows a resonance near the end of the deuteron range, and it is suggested that it is due to an excitation of the Ag nucleus induced by its own ionized electron structure. B. ROSE

539.172.13

**5263. The angular distribution of gamma-rays from $^7Li(p, p')^7Li^*$.** R. M. LITTAUER. Letter in *Proc. Phys. Soc., Lond. A*, **63**, 294 (*March*, 1950).

539.172.13

**5264. Carrier-free radioisotopes from cyclotron targets. VI. Preparation and isolation of $Ag^{105, 106, 111}$ from palladium.** H. R. HAYMOND, K. H. LARSON, R. D. MAXWELL, W. M. GARRISON AND J. G. HAMILTON. Letter in *J. Chem. Phys.*, **18**, 391–2 (*March*, 1950).

539.172.13

**5265. Nuclear pairs and gamma-radiation from excited states of $O^{16}$.** V. K. RASMUSSEN, W. F. HORNYAK, C. C. LAURITSEN AND T. LAURITSEN. *Phys. Rev.*, **77**, 617–22 (*March* 1, 1950).

The nuclear pairs and $\gamma$-radiation from the reaction $F^{19}(p, \alpha)O^{16*}$ have been studied at several of the resonances from 840 to 1 380 keV proton bombarding energy. The pair spectrum agrees well with that predicted theoretically for nuclear pairs, showing clearly that the pairs observed are not due to internal conversion of $\gamma$-radiation. The end point observed yields 6·04 ± 0·03 MeV for the location of the first excited state of $O^{16}$. The $\gamma$-radiation comprises at least two components, with relative intensities differing for the 4 resonances studied. The energies observed are 6·14 ± 0·04 MeV and 6·99 ± 0·05 MeV at the 873·5 and 1 381 keV resonances, and 6·14 ± 0·04 MeV and 7·09 ± 0·06 MeV at the 939 k resonance.

539.172

**5266. Theory of the D + D reactions. I. Analy of the energy dependence.** F. M. BEIDUK, J. PRUETT AND E. J. KONOPINSKI. *Phys. Rev.*, **77**, 622 (*March* 1, 1950).

The variations with energy of the newly extend observations on the D + D reaction products analysed. It is found adequate to assume that these variations, including details of the angu distributions, are due to differences in centrifu barriers met by different components of the incid deuteron waves. This is found possible only considerable spin-orbit interaction is allowed f The possibility is investigated that numerical measu of the interactions can be obtained from the expe mental data. Such conclusions as are permitted the nature of the data are presented.

539.172.

**5267. Theory of the D + D reactions. II. Relati to the internucleonic forces.** J. R. PRUETT, F. BEIDUK AND E. J. KONOPINSKI. *Phys. Rev.*, 628–33 (*March* 1, 1950).

The adequacy of current ideas about the int nucleonic forces in accounting for the observatic as analysed in Part I is investigated. In particul the adequacy of the spin-orbit coupling provided the tensor forces is examined. To this end, "minimal" formulation of the 4-body problem attempted. The interaction responsible for t reaction is derived. Some order-of-magnitu comparisons with the experimental data are pr sented.

539.172.

**5268. Spallation products of arsenic with 190-M deuterons.** H. H. HOPKINS, JR. Letter in *Phys. Re* **77**, 717–18 (*March* 1, 1950).

539.172.

**5269. Production of $C^{15}$.** E. L. HUDSPETH, C. SWANN AND N. P. HEYDENBURG. Letter in *Phys. Re* **77**, 736 (*March* 1, 1950).

539.172.

**5270. Protons from the deuteron bombardment separated neon isotopes.** A. ZUCKER AND W. WATSON. *Phys. Rev.*, **78**, 14–15 (*April* 1, 1950).

With Ne gas enriched either to 93% $Ne^{22}$ or to 99 $Ne^{20}$ the observations of Elder, Motz and Davis on the $Ne^{20}(d, p)Ne^{21}$ and $Ne^{22}(d, p)Ne^{23}$ reactio [Abstr. 2648 (1947)] are confirmed. Aided by t enrichment factor of 3 for $Ne^{21}$ in the "heavy" N a long-range proton group from $Ne^{21}(d, p)Ne^{22}$ wi a $Q$ of 6·79 ± 0·10 MeV is found for the reactio Consideration of these and other reactions involvi Ne isotopes show that the mass of $Ne^{21}$ is 21·00062 0·00010 and that this new proton group indicates excited state at 1·37 MeV in the $Ne^{22}$ nucleus.

539.172.

**5271. The emission of short-range alpha particl from light elements under proton bombardment. I Further observations on the reaction $^{10}B(p\alpha)^7B$** W. E. BURCHAM AND J. M. FREEMAN. *Phil. Mag* **41**, 337–48 (*April*, 1950).

The energy release in the reaction has be

sured, using targets of known thickness, and nd to be 1·147 ± 0·010 keV. Evidence for the tence of an excited state of energy about 400 keV he $Be^7$ nucleus was obtained. The cross-section the reaction was found by comparing the yield x-particles with the yield from the $B^{10}(n, \alpha)Li^7$ tion observed with the same target. A value of $\times 10^{-27}$ cm² at 330 keV proton energy was nd. A.

539.172.13 : 539.185

**2. The neutrons from the disintegration of llium by deuterons.** W. D. Whitehead and E. Mandeville. Letter in *Phys. Rev.*, **77**, 732–3 *arch* 1, 1950).

539.172.17 : 523.877

**roton-proton reactions in red dwarf stars.** *See tr.* 4672

539.172.3

**3. Determination of cross section for the photo-ntegration of deuteron.** K. Shinohara, T. Okada S. Morita. *J. Phys. Soc. Japan*, **4** (*No.* 2) 77–82 *rch–April*, 1949).

539.172.3

**4. On the photodisintegration of the deuteron.** Enatsu and Y. Takano. *Progr. Theor. Phys.*, **4**, –51 (*Oct.–Dec.*, 1949).

he modified pseudoscalar potential of Araki str. 5951 (1949)] is used, with approximate wave-ctions. The final $^3P$ state function for the toelectric effect is that for a square well of stable depth. The results are slightly less than se for the ordinary potential, using the same e-functions, and at 2·6 MeV markedly less than experimental value. G. J. KYNCH

539.172.3

**5. The effective range of nuclear forces. II. oto-disintegration of the deuteron.** H. A. Bethe C. Longmire. *Phys. Rev.*, **77**, 647–54 (*March* 1, 0).

ee Abstr. 5944 (1949). The theory of the ctive range is applied to the photo-disintegration of deuteron. For the photo-electric effect, the only portant influence of the range is through the malization of the ground state wave function. s found that this is given by an energy-independent or $(1 - \gamma r_{0t})^{-1}$, where $r_{0t}$ is the effective range of forces in the triplet state, and $\gamma$ is related to the ding energy of the deuteron. With the most likely erimental constants, this factor is 1·58 irrespective the shape of the nuclear potential. In the photo-gnetic case, the effect of the range on the matrix nent nearly compensates that on the normalization. cross-section is thus nearly the same as for zero ge of the forces. However, the cross-section is sitive to the difference of the effective ranges for let and singlet state, and can thus be used to ermine the latter ($r_{0s}$). The capture of slow trons by protons gives $r_{0s} \simeq 2{\cdot}6 \pm 0{\cdot}6 \times 10^{-13}$ cm, good agreement with the proton-proton scattering lts. In the last section it is shown that the effect ensor forces is unimportant. A.

539.172.3

**6. Cross sections for the photo-disintegration of rogen and oxygen nuclei by 100-Mev betatron X-rays.** E. R. Gaerttner and M. L. Yeater. Letter in *Phys. Rev.*, **77**, 714 (*March* 1, 1950).

539.172.3

**5277. Yields and angular distributions of some gamma-neutron processes.** G. A. Price and D. W. Kerst. *Phys. Rev.*, **77**, 806–9 (*March* 15, 1950).

Measurements of $\gamma, n$ yields for 53 elements have been made using betatron bremsstrahlung with maximum energies of 18 MeV and 22 MeV. The neutron flux was observed by a Rh detector and compared with a standard Ra–Be neutron source. In the region from $Z = 22$ to $Z = 83$ the $\gamma, n$ yield in neutrons per mole per $r$ of radiation is observed to be $2\,270Z^{2\cdot1}$ when the bremsstrahlung spectrum has a 22 MeV maximum energy. The regularity of neutron yield as a function of atomic number indicates a definite similarity in the $\gamma, n$ cross-section curves for neighbouring heavy elements. The trend of the observed yields is in rough agreement with the yields predicted by Goldhaber and Teller. Estimates are made of the fractions of Th and U atoms which undergo photo-fission. Angular distributions of photo-neutrons using bremsstrahlung with a 19·7 MeV maximum energy show no spherical asymmetry greater than the probable error for Fe and Pb whereas D and Be have maxima at 90°. A.

539.172.4

**5278. Some remarks on the capture cross-section of slow and fast neutrons in heavy elements.** L. Meitner. *Ann. Phys., Lpz.*, **3**, 115–19 (1948) *In German.*

Cross-sections for the reactions $Ta^{181}(n, \gamma)Ta^{182}$ and $Cb^{93}(n, 2n)Cb^{92}$ (using fast neutrons from the Li + D reaction, $E_D = 6$ MeV) show that the latter is about 500 times smaller. The ratio of fast to slow $n$ capture cross-section for the former was also measured (= 0·26), by slowing down the neutrons with 5 cm of paraffin, and compared with the corresponding ratio for $Au^{197}$(= 0·077). Using known values for the slow neutron cross-sections [Havens, Wu, Rainwater and Meaker, Abstr. 1318 (1947)] the cross-sections for the fast Li + D neutrons are deduced to be $6{\cdot}7 \times 10^{-25}$ and $3{\cdot}8 \times 10^{-25}$ cm² respectively (± 20%). The explanation of the abnormally low cross-sections for $Pb^{208}$, $Bi^{209}$, $Cb^{93}$ in terms of the high spins (9/2) of the initial or final nucleus involved [Maurer and Ramm, *Z. Phys.*, **119**, 602 (1942)] is criticized in view of these results.

W. J. SWIATECKI

539.172.4

**5279. $(n, 2n)$- and $(\gamma, n)$-reaction cross-sections.** P. Jensen. *Ark. Fys.*, **1**, *Paper* 25, 515–31 (1949) *In German.*

Li + D neutrons from a cyclotron (maximum $n$ energy = 18 MeV) were used to irradiate compounds of $N^{14}$, $F^{19}$, $K^{39}$ and $Sc^{45}$, and activities resulting from $(n, 2n)$ reactions in these nuclei were measured. Assuming the energy dependence of the cross-section to be of the form predicted by the statistical theory of nuclear reactions, and using a computed neutron spectrum (based on measurements at low energies) a quantity $\sigma_0$ was deduced from the yield for each element such that, other things being equal, the values of $\sigma_0$ would be $\propto$ the geometrical cross-

sections of the bombarded nuclei. This appears to hold for F and Sc, but for N and K the values of $\sigma_0$ are too small by a factor $\sim 7$. Possible causes of the discrepancies are discussed. On Bohr's theory of nuclear reactions, the cross-sections for $(n, 2n)$ and $(\gamma, n)$ processes for a given initial nucleus contain a common factor. Values of $(\gamma, n)$ yields and cross-sections are compared with the author's $(n, 2n)$ results, but no definite conclusions are drawn.

A. P. FRENCH

539.172.4

**5280. Engineering aspects of nuclear reactors. III.** L. A. OHLINGER. *Nucleonics*, **6**, 54–63 (*Feb.*, 1950).

General discussion of constructional details and operation of nuclear reactors. L. R. SHEPHERD

539.172.4

**5281. The 5-Ev neutron resonance in Ag.** W. SELOVE. Letter in *Phys. Rev.*, **77**, 557 (*Feb.* 15, 1950).

539.172.4

**5282. Star fragments in oxygen and helium under bombardment by 90-Mev neutrons.** J. TRACY AND W. M. POWELL. *Phys. Rev.*, **77**, 594–6 (*March* 1, 1950).

A study has been made of 82 stars produced in a mixture of O and He when a cloud chamber filled with these gases and placed in a magnetic field of 13 000 gauss was bombarded by 90 MeV neutrons. Stars having up to 5 prongs were observed. Of the forty-eight 2-prong stars, 14 could be reasonably assigned to O and 14 to He. The remaining 20 were unidentified. It was found possible to make plausible identifications of all the fragments from only 7 He stars and one 5-prong O star. The general identification procedure is discussed and the arguments for the one 5-prong O star are presented in some detail. Histograms of the $H\rho$ and scatter-angle distributions of the star fragments are given. A.

539.172.4

**5283. Nuclear cross sections for 95-Mev neutrons.** J. DEJUREN AND N. KNABLE. *Phys. Rev.*, **77**, 606–14 (*March* 1, 1950).

The total cross-sections of 12 different elements were measured using the neutron beam from the 184 in cyclotron operating with deuterons. Bi fission ionization chambers were employed as both monitor and detector in conventional "good geometry" attenuation measurements in the neutron flux emerging from the 3 in diameter collimating port in the 10 ft thick concrete shielding. The mean energy of detection of the neutrons in this experiment is estimated to be 95 MeV. Measurements were also made with a monitor and detector placed inside the concrete shielding where an intense neutron flux could be obtained over a large area. Attenuators of 4 different elements were placed in front of the detector in a "poor geometry" arrangement so that attenuation was due essentially to inelastic collisions which degrade the neutron energy below the fission threshold. A second detector was placed outside the concrete shielding in the collimated neutron beam in line with the neutron source, absorber and first detector. Attenuation in it is caused by both inelastic and elastic scattering. By this arrangement the ratio of inelastic to total cross-section can be determined directly in one experiment. The nuclear radii as calculated from the observed cross-sections using the theory of the transparent nucleus vary by $1{\cdot}38 \times 10^{-13}\ A^{\frac{1}{3}}$ cm. In this energy range the ratios of the inelastic to total cross-sections are all $< \frac{1}{2}$.

539.172

**5284. Ionization chamber study of the disintegration of $He^3$ and $N^{14}$ by thermal neutrons.** W. FRANZEN, J. HALPERN AND W. E. STEPHENS. *Phys. Rev.*, 641–6 (*March* 1, 1950).

The total ionization produced by the reactions $He^3(n, p)$ and $N^{14}(n, p)$ in a gas mixture consisting mainly of A was measured by means of a cylindrical ionization chamber operated under conditions of electron collection. High resolution was achieved by suitable choice of chamber geometry and by use of a low-noise-level amplifier. The total ionization charges collected from Po $\alpha$-particles, from the disintegration products of $He^3(n, p)$ and from those of $N^{14}(n, p)$ are found to be in the ratio $1 : 0{\cdot}145 : 0{\cdot}002 : 0{\cdot}119 \pm 0{\cdot}001$ respectively. Compared with Po $\alpha$-particles on the assumption of a constant average energy per ion pair in A then yields reaction energies of $766 \pm 10$ keV for $He^3(n, p)$ and 630 ± 6 keV for $N^{14}(n, p)$. The difference between these energies agrees well with the difference between the end points of the $\beta$-ray spectra of $C^{14}$ and $H^3$. This agreement supports the assumption of a proportionality between energy and ionization in A independent of particle type. A value of $785 \pm 6$ keV is computed for the neutron-hydrogen mass difference from these data.

539.172

**5285. The $Cu^{63}(n,2n)Cu^{62}$ cross section as a function of neutron energy near the threshold.** J. L. FOWLER AND J. M. SLYE, JR. *Phys. Rev.*, **77**, 787–9 (*March* 15, 1950).

Using the $D(d, n)He^3$ reaction produced by 10·5 MeV deuterons to give monoenergetic neutrons, the $Cu^{63}(n, 2n)Cu^{62}$ reaction has been studied in the vicinity of the threshold. The product of the differential cross-section of the former reaction and the activation cross-section of the latter is obtained as a function of angle to the bombarding $d$ beam. By calibrating the Geiger counters with $\beta$-particles from $Cu^{66}$ produced by the thermal neutrons on $Cu^{65}$, the data are made absolute in terms of the known thermal capture cross-section. Previous measurements of the differential cross-section of the $D(d, n)He^3$ reaction allow the $Cu^{63}(n, 2n)Cu^{62}$ cross-section to be given as a function of energy. An extrapolation of the data gives the energy required to remove a neutron from $Cu^{63}$ as $11{\cdot}2 \pm 0{\cdot}3$ MeV. A

539.172

**5286. The thermal neutron-capture cross section of $A^{36}$.** G. E. MCMURTRIE AND D. P. CRAWFORD. Letter in *Phys. Rev.*, **77**, 840 (*March* 15, 1950).

539.172

**5287. Energy spectrum of fragments from the spontaneous fission of natural uranium.** W. J. WHITEHOUSE AND W. GALBRAITH. *Phil. Mag.*, **41**, 429–43 (*May*, 1950).

A direct comparison is made between the energy

trum of fission fragments from the spontaneous on and from the thermal-neutron-induced fission ne same foils of natural U. The results show that, in the limits of the experiment, the two distri- ons are not significantly different from one ther. Calculations are made which indicate the nitude of the distortion of the energy spectrum to xpected, and the theory is found to agree satis- orily with experiment. As a subsidiary result to main experiment the rate for the spontaneous on of natural U is found to be 24·2 ± 1·5 per hr g. A.

539.172.4 : 535.376

**xcitation of phosphors by the energetic fission ments of uranium.** *See Abstr.* 4872

539.172.4 : 539.152.1

**8. Fission and nuclear shell model.** L. MEITNER. er in *Nature, Lond.*, **165**, 561 (*April* 8, 1950).

the "magic" neutron numbers 50 and 82 are med to condition the most probable mode of on of $U^{235}$, then only those values of fragment rge are allowed which possess these closed neutron ls. This is borne out by the experimental fission d curve. In Bi only 116 neutrons are available, so both fragments should have a shell of 50 trons. This is confirmed by experiments on the on of Bi by 200 MeV deuterons; the most prob- mode of fission being symmetrical at charges nected with this closed shell. For very high itation the closed shells should not persist and r the evaporation of a number of neutrons sym- rical fission is most probable. This is borne out ission produced by 360 MeV α-particles.

J. HUGHES

539.174

**9. Nuclear isomerism of $^{80}_{35}Br$ and its neutron ture levels.** P. C. CAPRON. *Mém. Acad. Roy. g. Cl. Sci.*, **21** (*No.* 7) 36 *pp* (1948) *In French.*

eport of work done 1938–1942 on the production $Br^{80}$ and $Br^{80*}$ by bombardment of $CBr_4$ with rmal and resonance neutrons. There is more than neutron capture level, but they are too close to lve: the ratio of $Br^{80}$ to $Br^{80*}$ produced decreases h increasing energy of the incident neutrons.

A. O. STANESBY

539.174 : 537.534.74

**nelastic scattering of protons by Mg, Al, etc.** *Abstr.* 5051

539.174 : 539.185 : 539.166

**0. Electromagnetic emission under the influence exchange-forces.** I. POMERANCHUK AND I. MUSHKEVICH. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 1) 6 (1950) *In Russian.*

As has been shown [Abstr. 1239 (1950)] exchange ces can increase the intensity of photon emission ing collision of protons and neutrons. In collision h heavy nuclei the approaching particle may suffer eral collisions with individual nucleons before ving the nucleus. An estimate of the intensity of ission is made, treating the motion of the approach- particle classically. J. JACOBS

## ATOM AND MOLECULE BEAMS MESONS . NEUTRONS 539.18

539.18

**5291. Remarks on the measurement of the rest masses and the linear dimensions of ultra-fast particles.** R. FÜRTH. *Ann. Phys., Lpz.* (*Folge* 6) **3**, 7–10 (1948).

Theoretical. Assuming the rest mass, $m$, of a relativisitic particle to be determined from the small difference between momentum and energy, the error in $m$ is shown to be so large that particles with different rest masses cannot be distinguished from each other. Their linear dimensions may be deduced from the interactions between two streams crossing each other at right-angles. The error in such an experiment is shown to be impossibly large also.

E. P. GEORGE

539.18

**5292. On the nature of the τ-meson.** H. FUKUDA, S. HAYAKAWA AND Y. MIYAMOTO. Letter in *Progr. Theor. Phys.*, **4**, 388–9 (*July–Sept.*, 1949).

539.18

**5293. The another τ-meson.** S. HAYAKAWA AND Y. YAMAGUCHI. Letter in *Progr. Theor. Phys.*, **4**, 570–1 (*Oct.–Dec.*, 1949).

These are those mesons, heavier than π-mesons, which do not show spontaneous decay into 3 lighter mesons. They are also called τ mesons. The experimental evidence advanced for the existence of τ′ mesons is accepted, and their nuclear coupling discussed. E. P. GEORGE

539.18

**5294. On the mu-meson capture.** M. TAKETANI, M. SASAKI AND S. NAKAMURA. *Progr. Theor. Phys.*, **4**, 552–6 (*Oct.–Dec.*, 1949).

The excitation energy at $\mu^-$-meson capture is estimated to be $\sim 6$ MeV for large $Z$ and $\sim 14$ MeV for small $Z$ (e.g. $Z = 4$). Alternative interaction schemes among nucleons, π-mesons, μ-mesons and leptons are examined. The way in which π-mesons can be introduced to the Wheeler interaction triangle must be determined by the fact that π-mesons decay to μ-mesons and not to electrons. J. G. WILSON

539.18

**5295. Remarks on multiple meson and gamma-ray production.** R. E. MARSHAK. Letter in *Phys. Rev.*, **76**, 1736 (*Dec.* 1, 1949).

The implications of the interpretation of the large α induced explosion [Abstr. 3252 (1950)], and of Berkeley experiments (unpublished) on high energy γ-rays, in terms of the γ decay of a neutral meson of mass about 300 and of lifetime $\gtrsim 10^{-13}$ sec, are examined. It is concluded that if this star is typical of the origin of an Auger shower, multiple cores in the showers are not to be expected, but that the analysis of the shower decoherence curves may be of value to determine the angular distribution and energy of the neutral (and therefore of all) mesons.

J. G. WILSON

539.18

**5296. On the changing status of mesons.** J. N. SNYDER. *Amer. J. Phys.*, **18**, 41–9 (*Jan.*, 1950).

Review of recent developments for non-specialists. (80 refs.)

539.18

**5297. Phase-shift formula for many-body collisions.** R. Kołodziejski. Letter in *Nature, Lond.*, **165**, 110–11 (*Jan.* 21, 1950).

The scattering of a particle by an almost spherically symmetrical system of $N$ particles is considered, taking into account the "adiabatic" deformation of the scattering system during the collision. The method will be of use in treating the elastic scattering of negative mesons by atoms and of neutrons by deuterons. P. M. DAVIDSON

539.18

**5298. Mesons produced by neutrons from the cyclotron.** F. M. Smith, E. Gardner and H. Bradner. Letter in *Phys. Rev.*, **77**, 562–3 (*Feb.* 15, 1950).

Neutrons from the bombardment in the cyclotron of an internal target with 345 MeV protons are shown to produce stars in Ilford C2 emulsion from about $10^{-4}$ of which mesons were observed. J. G. WILSON

539.18

**5299. Possible experimental determination of whether the neutral meson is scalar or pseudoscalar.** C. N. Yang. Letter in *Phys. Rev.*, **77**, 722–3 (*March* 1, 1950).

If the neutral meson is scalar, the 2 decay photons would have parallel polarization; if pseudoscalar, perpendicular. An experiment based on this difference is proposed. E. P. GEORGE

539.18

**5300. Scattering of pseudoscalar charged mesons by nucleons. II.** E. Corinaldesi and G. Field. *Phil. Mag.*, **41**, 364–9 (*April*, 1950).

The fourth- and sixth-order contributions to the scattering cross-section are evaluated for the non-relativisitic region. Damping effects are also considered. A.

539.18

**5301. γ-decay and mesons of spin zero.** C. B. van Wyk. *Proc. Phys. Soc., Lond. A*, **63**, 350–7 (*April*, 1950).

On the assumption that $\tau$-mesons are scalar particles and have an appreciable interaction with nucleons, the lifetime of a $\tau$-meson at rest decaying into two photons and a pseudoscalar $\pi$-meson, is calculated by means of standard perturbation theory. The lifetime obtained is $G\times10^{-12}$ sec where $G$ is the reciprocal of the product of the dimensionless meson-nucleon coupling parameters. This result is roughly what can be expected from observations and, taken together with the results of a previous paper, seems to indicate that the heavy mesons have spin zero. A.

539.18

**5302. Production of π-mesons by high energy electrons.** E. Strick and D. ter Haar. Letter in *Phys. Rev.*, **78**, 68–9 (*April* 1, 1950).

539.18

**5303. On the ratio of positive and negative photo-mesons.** O. Halpern. Letter in *Phys. Rev.*, **78**, 69 (*April* 1, 1950).

539.18 : 530.145

**Applicability of Pauli's regulator to the γ-decay of neutrettos.** *See Abstr.* 4710

539.18 : 530.1

**On the production of π-mesons in the nucle nucleon collisions.** *See Abstr.* 4711

539.18 : 537.5

**Some decay effects of mesons in penetrating show observed in a high-pressure Wilson cloud cham** *See Abstr.* 5111

539.18 : 539.

**On the reflection of particles of spin $h/2\pi$** *Abstr.* 4709

539.18 : 539.17

**5304. Relative yield functions for π⁻-mesons fr carbon.** S. B. Jones and R. S. White. *Phys. R* **78**, 12–13 (*April* 1, 1950).

Describes determinations of the relative yi curves for $\pi^-$-mesons generated by α-particle an beams striking C targets. The mesons counted h energies of 2–10 MeV and angles to the beam direct up to about 45°.

539.1

**5305. On the theory of diffusion of thermal neutr in a hydrogenous substance.** D. Lyons. *Ann. Ph Lpz.*, **4** (*No.* 7) 379–88 (1949) *In German.*

539.1

**5306. On the theory of the age and the moderat of neutrons.** C. Sánchez del Río. *An. Real. S Esp. Fís. y Quím.*, **45A**, 457–61 (*Sept.–Oct.*, 1949) *Spanish.*

A simple argument employed by Friedman justify the age theory of the slowing down of neutr has been reworked to give a more rigorous pr which enables one to deduce the assumptions un which the use of the theory is correct.

539.1

**5307. Pile neutron research techniques. I.** D. Hughes. *Nucleonics*, **6**, 5–17 (*Feb.*, 1950).

The chain reacting pile is considered as a source fast and intermediate energy neutrons. Beams thermal neutrons mixed with fast and intermedia energy neutrons having a $1/E$ distribution may obtained through holes which penetrate into the pi lattice. If the holes open only into the therm column (a column of moderating material extendi from the pile reflector through the shield) then t beams consist almost entirely of thermal neutron Fast neutrons can be obtained by placing U co vertors in thermal beams and filtering out residu thermal neutrons by means of Cd screens. Th process gives fission neutrons of effective ener $\sim$ 1 MeV. Measurements of fast $n$ capture cro sections using fission neutrons obtained in th manner are described. Measurements in the inte mediate range may be carried out by isolating t effect of selected regions of the $1/E$ spectrum prese in pile neutron beams. This may be done by use suitable resonance detectors or filters or by use of crystal monochromator or velocity selecter.

L. R. SHEPHER

539.18

**5308. A new method for determining the relativ phase with which slow neutrons are scattered by nucle** P. J. Bendt and I. W. Ruderman. *Phys. Rev.*, **7** 575–9 (*March* 1, 1950).

To determine this for an element $A$, cross-sectio

surements are obtained for $A$, for a reference ent $B$, and for a substitutional solid solution of nd $B$. The experimental value of the effective rent scattering cross-section, $\sigma'_{coh}$, for the solid tion, when compared with the values calculated the data for pure $A$ and $B$, shows whether the constituent elements scatter neutrons in the or in opposite phases. Measurements made the Columbia neutron velocity spectrometer v that Cu and Ni scatter with the same phase, Mn and Ni with opposite phases, in agreement other methods of phase determination. The wing more accurate values of the free scattering s-sections, $\sigma_f$, and new values of the effective rent scattering cross-sections, $\sigma'_{coh}$, were ob-ed: Cu, $\sigma_f = 8{\cdot}2$ barns, $\sigma'_{coh} = 6{\cdot}6$ barns; Ni, $= 17{\cdot}4$ barns, $\sigma'_{coh} = 13{\cdot}9$ barns; Mn, $\sigma_f =$ ) barns. $\sigma'_{coh} = \sim 1{\cdot}9$ barns. A.

539.185

**). Elastic scattering of 84-Mev neutrons.** BRATENAHL, S. FERNBACH, R. H. HILDEBRAND, E. LEITH AND B. J. MOYER. *Phys. Rev.*, **77**, 605 (*March* 1, 1950).

easurements have been made of the angular ibution of 84 MeV neutrons scattered into angles veen $2\frac{1}{2}°$ and 25° by Al, Cu and Pb nuclei. Small res of these elements were placed in the neutron n of the 184 in cyclotron and the scattered rons with energies $> 20$ MeV were detected pieces of C activated by the $C^{12}(n,2n)C^{11}$ reaction. l scattering cross-sections were obtained by gration of the differential scattering cross-sections also by attenuation measurements with good poor geometry. A.

539.185

**). Resonance neutron scattering in $Na^{23}$ at ) Ev.** C. T. HIBDON, C. O. MUEHLHAUSE, W. OVE AND W. WOOLF. Letter in *Phys. Rev.*, **77**, 1 (*March* 1, 1950).

539.185 : 539.172.4

**. The method of quantitative autoradiography its application to the determination of the neutron ibution in the surrounding absorbers.** D. T. RUS. *Istanbul Univ. Fen. Fak. Mec., Ser. A*, **14**, 80 (*Oct.*, 1949) *In German.*

he reaction $Au^{197}(n,\gamma)Au^{198}$ has been used to stigate the following problems using the quanti-e autoradiograph method:—The absorption co-ient of Au for slow neutrons from any direction determined as $9{\cdot}5 \pm 1\ cm^{-1}$. The m.f.p. of mal neutrons in water was found to be $\pm 0{\cdot}1$ mm. The neutron distribution near the of a Cd foil was determined. The albedo of ffin for thermal neutrons was estimated as $0{\cdot}80 \pm 0{\cdot}02$. Likewise the average number of ron collisions in paraffin becomes $N = 103 \pm 20$. G. O. BAINES

539.185 : 545.8

**eutron spectroscopy for chemical analysis. II.** *Abstr.* 5391

539.185 : 778.3

**. Measurement of fast neutron energies by rvation of $Li^6(n,\alpha)H^3$ in photographic emulsions.** G. R. KEEPIN, JR. AND J. H. ROBERTS. *Rev. Sci. Instrum.*, **21**, 163–6 (*Feb.*, 1950).

A new technique of neutron energy measurement not requiring neutron collimation is described. The method employs the nuclear reaction $Li^6(n,\alpha)H^3$ ($Q = 4{\cdot}64$ MeV) observed within photographic emulsions impregnated with enriched $Li^6$. Results on monoenergetic neutrons indicate a resolution of at least $\pm 0{\cdot}1$ MeV in the region studied (from thermal energies up to $1{\cdot}3$ MeV). To extend the method to measurement of continuous neutron spectra, both the excitation function and the angular distribution of the $Li^6$ disintegration process should be known. However, for immediate practical application, the method may be calibrated with a well-known spectrum. The technique is well suited to measurements within a material medium where perturbations introduced by the detector must be minimized and where collimation is clearly impossible. A.

539.185.08

**5313. On the measurement of the density of thermal neutrons.** E. CORINALDESI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Fis. Mat. Nat.*) **1**, 982–90 (*Sept.*, 1946) *In Italian.*

Formulae are given for correcting for the perturbation produced in the distribution of the neutrons by the presence of the detector (generally a substance which becomes radioactive by absorption of thermal neutrons). L. PINCHERLE

539.185.08 : 537.312

**5314. Pd film fast neutron detector.** B. R. GOSSICK. Letter in *Phys. Rev.*, **77**, 297 (*Jan.* 15, 1950).

Utilizes the resistance variation of a Pd film fired on ceramic core, under recoil proton bombardment. A resistor with exposed Pd film, coated with paraffin and irradiated at full power in the Oak Ridge pile, showed a fall in resistance to $0{\cdot}5\%$ of the initial value after 15 hr. Similar resistance change was obtained by exposing a resistor in a H atmosphere at 44 cm pressure and by heating to 900°c in an N stream. There is indication that these treatments produce a reduction to Pd metal of the oxide originally present in the film. L. R. SHEPHERD

539.185.08 : 771.535

**5315. The measurement of intense slow neutron fluxes by the photographic method.** R. LOCQUENEUX. *J. Phys. Radium*, **11**, 144–52 (*March*, 1950) *In French.*

The emission of protons produced by slow neutrons from the N in photographic emulsions is studied from the point of view of dosage. According to the emulsion composition and thickness, fluxes from $10^7$ to $10^{12}$ neutrons/cm$^2$ can be determined conveniently. The various sources of error are discussed. The most serious are local variations in the emulsion, such as variations in silver halide concentration, in sensitivity, or in processing. A new point on the range energy curve for Ilford C2 emulsions was determined for slow protons ($0{\cdot}54$ MeV). W. F. BERG

539.185.08 : 778.33

**5316. On the use of photographic plate detectors in neutron experiments.** J. C. Allred, A. N. Phillips, L. Rosen and F. K. Tallmadge. *Rev. Sci. Instrum.*, **21**, 225–8 (*March*, 1950).

A technique is discussed for utilizing photographic plate detectors in an evacuated camera, containing an appropriate radiator, to make precise determinations of the range distributions of the disintegration products of slow neutron reactions. The same technique is applied to the problem of measuring neutron energies by making range measurements on the forward recoil protons projected by fast neutrons from a thin polyethylene radiator. As an indication of the accuracy attainable with photographic plates when used in this manner, determinations have been carried out for the $Q$ values of the $Li^6(n, \alpha)H^3$ reaction and the $B^{10}(n, \alpha)Li^7$ reaction. A.

539.185.08 : 778.33

**5317. Photographic methods of measuring slow neutron intensities.** M. Blau, I. W. Ruderman and J. Czechowski. *Rev. Sci. Instrum.*, **21**, 232–6 (*March*, 1950).

The relative slow neutron sensitivities of $\beta$-sensitive emulsions, X-ray film/In foil combinations and B-loaded plates were investigated. Since the detection efficiency depends upon the neutron energy, experiments were made with epithermal, thermal and cold neutrons. $\beta$-sensitive emulsions and X-ray/In combinations are about equally useful for the detection of epithermal neutrons. $B^{10}$ loaded plates, which are best for the detection of thermal and cold neutrons, have the following advantages: very low neutron intensities can be measured by microscopic counting of $\alpha$-tracks, neutrons can be counted in the presence of $\beta$- and $\gamma$-radiation, the number of $\alpha$-tracks is essentially independent of the development conditions, and a wide range of neutron intensities can be measured with a single plate. A.

539.185.7 : 539.166.75

**5318. On the shielding qualities of different concrete mixtures.** P. C. Gugelot and M. G. White. *J. Appl. Phys.*, **21**, 369–79 (*May*, 1950).

Absorption curves for neutrons and $\gamma$-radiation produced by 16 MeV protons on Be are measured in absorber blocks of various concrete mixtures to obtain information on their shielding properties. It is shown that a mixture of cement, scrap iron and limonite ore is as efficient as water in slowing down and capturing neutrons and, in addition, has sufficient density ($\rho = 3{\cdot}5$ g/cm$^3$) to be an effective absorber for $\gamma$-radiation. Compared to ordinary concrete, a three-foot wall of iron and limonite concrete is superior by a factor of 280 for neutrons and by a factor of 20 for $\gamma$-radiation. Boron is shown to be of little value in this type of shielding. Mechanical properties of the scrap iron/limonite concrete are satisfactory for structural purposes. From the practical cost standpoint, a concrete made entirely of limonite ore is shown to be a reasonable compromise. A.

539.185.9 : 541.14

**Molecules formed after irradiation of organic bromides with neutrons.** *See Abstr.* 5385

## STRUCTURE OF SOLIDS 539.2

539

**5319. A new theory of recrystallization nuc** R. W. Cahn. *Proc. Phys. Soc., Lond. A*, **63**, 323 (*April*, 1950).

A new theory is presented of nucleus formati when a cold-worked metal is annealed.

539.2

**5320. Separation of small spheres according to si** W. Paul and R. V. Jones. Letter in *Researc Lond.*, **3**, 98–9 (*Feb.*, 1950).

The spheres are released simultaneously in a sta liquid column whose specific gravity increases fr top to bottom, and the different sizes selected changing the receiver at suitable times. Spheres Hysil glass between 5 $\mu$ and 40 $\mu$ dia. can be separat in a column 20 cm high, density increasing from 0 to 1 g/cm$^3$, taking about 3 hr. The method can modified for larger spheres. N. CORCOR

539.2

**5321. The thermal stabilization and sintering of g smoke deposits.** L. Harris, D. Jeffries and B. Siegel. *J. Chem. Phys.*, **18**, 261–5 (*March*, 1950).

539.21

**5322. Intrinsic block structure and the strength metals.** M. S. Paterson. *Phil. Mag.*, **41**, 410 (*Apr* 1950). See Abstr. 2749 (1949).

539.215.2 : 548.

**Orientation-dependence of rate of grain bounda migration.** *See Abstr.* 5393

539.2

**5323. The permeability of porous materials.** E. Childs and N. Collis-George. *Proc. Roy. Soc.* **201**, 392–404 (*April* 26, 1950).

539.23 : 548.

**5324. Electronographic investigation of films polyvinyl alcohol. I.** G. I. Distler and Z. G. Pinske *Zh. fiz. khim.*, **23**, 1281–91 (1949) *In Russian.*

An electron-diffraction study, giving 3–5 $d$ values f several polymers. A. J. C. WILSO

539.2

**5325. The structure of obliquely evaporated fil and their influence on the formation of sub-microsco surface irregularities.** H. König and G. Helwi *Optik*, **6**, 111–24 (*Feb.*, 1950) *In German.*

The background structure revealed in electr microscope photographs of "shadow-cast" objects shown to be due, not to irregularities of the collodi substrate, but to the structure of the evaporated fil The granularity depends upon the angle of incide and the thickness of the evaporated film and independent of the material of the substrate. Phot graphs on glass and collodion show that for obl quities $> 20°$ the particle size can be reduced 50–70 Å with a Pt–Pd film and finer still with a fil of wolfram oxide. The aggregation of Au films in high density electron beam can be prevented b covering the Au with a thin coating of varnish aft evaporation. R. W. FI

539.232 : 537.533.73

**5. The crystallochemical mechanism of the nation of oxide layers on iron at room temperature.** D. Dankov and N. A. Shishakov. *Zh. fiz. n.*, **23**, 1031–5 (1949) *In Russian.*

n electron diffraction study. A. J. C. Wilson

539.234 : 548.538

**7. Surface tension effects in oriented thin silver s.** G. W. Johnson. *J. Appl. Phys.*, **21**, 449–53 *y*, 1950).

tructural changes of thin oriented films of Ag duced by condensation in a vacuum on cleaved aces of single crystals of rocksalt were followed function of temperature. Marked agglomeration urred in films of thicknesses $< 1\,000$ Å. For ker films in the 1 000–2 000 Å range rectangular es appeared in the films with their edges aligned n the 110 directions of the rocksalt. The effects attributed to the readjustment of the oriented ace under the influence of surface tension forces. A.

539.26

**8. An X-ray micro-beam examination of a stically deformed metal.** J. N. Kellar, P. B. sch and J. S. Thorp. *Nature, Lond.*, **165**, 554–6 *ril* 8, 1950).

539.26

**9. Load induced X-ray line broadening in nylon ments.** J. Kauffman and W. George. *J. Appl. s.*, **21**, 431–4 (*May*, 1950).

he load-induced microscopic structural changes in hly oriented nylon filaments were followed by nges in the X-ray fibre diffraction pattern as a ction of the resulting strain. Observations made luded (1) changes in the dimensions of the fibre ts, and (2) a decrease in ratio of the intensity of orphous to crystalline X-ray scattering. These ults indicate a change in the micro deformation chanism at a strain corresponding to the inflection the load-strain diagram (14% elongation). The chanism for smaller plastic strains appears to olve a rotation of the crystallized domains into gnment with the fibre axis, accompanied by a small erall additional crystallization. For strains larger n the inflectional strain, the mechanism seems to olve a progressive reduction in the domain size, d a reduction in alignment with the fibre axis. th effects appear to saturate in the vicinity of the ture strain. These results are discussed in terms load-induced effects found in metal single and lycrystals. It is suggested that the qualitative tures observed may be representative of a wide ss of load- or strain-induced microdeformation ctions in the solid state. A.

539.26 : 539.4.016.2 : 539.215.2

**30. Geiger-counter measurement of the diffuse ttering of X-rays by crystals and the effect on it of stic deformation.** G. Wagner and A. Kochenrfer. *Ann. Phys., Lpz.*, **6**, 129–44 (1949) *In rman.*

Cu $K\alpha$ radiation was reflected by a pentaerythritol stal into the collimator system of a spectrometer ed with a movable Geiger counter suitably shielded. ecimens used were Zn single crystals and polycrystalline Al and Ag. The diffuse scattering from the Zn was measured in various regions of the *hhl* section of the reciprocal lattice, but no effects attributable to cold-work (extension up to 32%) were found, though irregular changes of $\sim 10\%$ occurred. Similarly, the general diffuse scattering from polycrystalline Al and Ag showed no systematic changes with degree of rolling (reductions up to 99%). The ratio of the integrated intensities of Ag 004 and 002 remained at $0{\cdot}119 \pm 4$ for deformations of 10 to 65%. It is concluded that the intensities of the diffuse scattering and of the ordinary reflections are unaffected by cold work within the accuracy of measurement.

A. J. C. Wilson

539.264

**5331. Deficiencies in order of large size in fibrous systems.** R. S. Bear and O. E. A. Bolduan. *Acta Cryst.*, **3** (*No.* 3) 230–5 (1950).

539.264

**5332. Diffraction by cylindrical bodies with periodic axial structure.** R. S. Bear and O. E. A. Bolduan. *Acta Cryst.*, **3** (*No.* 3) 236–41 (1950).

Three models are considered: (1) the smooth cylinder, whose radius is everywhere constant; (2) the corrugated cylinder, whose radius is a periodic function of position along the cylinder with the same period as the axial density variations; and (3) the compound cylinder, which is composed of thin, parallel, smooth cylinders displaced axially from perfect transverse matching of their identical axial density fluctuations. A.

539.27

**5333. Aluminum oxide replicas for electron microscopy produced by a two-step process.** G. Hass and M. E. McFarland. *J. Appl. Phys.*, **21**, 435–6 (*May*, 1950).

539.27

**5334. A study on corrosion of iron by electron diffraction.** H. Yoshioka. *J. Phys. Soc. Japan*, **4**, 270–5 (*July–Dec.*, 1949).

539.27

**5335. Electron diffraction studies on oxide films formed on metals and alloys. I. Oxidation of pure copper.** G. Honjo. *J. Phys. Soc. Japan.* **4**, 330–3 (*July–Dec.*, 1949).

539.27

**5336. Some work done with the magnetic electron microscope.** G. Dupouy. *Rev. Opt.* (*Théor. Instrum.*) **29**, 89–100 (*Feb.*, 1950) *In French.*

Describes researches carried out using the magnetic electron microscope built at Toulouse. This includes work on diatoms both as test pieces and also on their morphology. Metallographic studies have been carried out by the surface replica technique, which is briefly described. A. H. W. Beck

539.27 : 771.53

**5337. An electron microscope study of photographic plate surfaces.** R. Reed and A. Millard. *Proc. Leeds Phil. Lit. Soc.*, **5**, 81–8 (*Dec.*, 1948).

A replica method for the examination of photographic emulsions is described, and results are given showing the shape, size and distribution of surface grain under various conditions. The surfaces of commercial plates so far examined are rough, con-

sisting of grain coated with a thin layer of gelatin. Only in one plate, which is very sensitive to electrons, do the grains appear to lie on the surface without a confining layer of gelatin. Developed grains of an open fibrous nature have been shown to occur on plate surfaces. The effect of light and electron beams on photographic plates is illustrated, and the possible composition of plates of high electron sensitivity is discussed. A.

## ELASTICITY . STRENGTH . RHEOLOGY
## 539.3/.8

539.31

**5338. On the existence of a solution of an elasticity problem.** C. Arf. *Istanbul Univ. Fen Fak. Mec., Ser. A*, **14**, 75–85 (*April*, 1949) *In French.*

It is proved that the system of equations derived in a previous paper [Abstr. 4185 (1949)] has a solution, which is not necessarily unique. J. G. OLDROYD

539.31

**5339. Elastico-plastic straining when the principal stresses rotate.** K. H. Swainger. Letter in *Nature, Lond.*, **165**, 360–1 (*March* 4, 1950).

539.313

**5340. Behaviour of paper under stress and strain.** B. Steenberg. *Pulp. Pap. Mag. Can.*, **50** (*No.* 3) (*Convention issue*) 207, 220 (1949).

By means of a series of new recording instruments the stress-strain behaviour of paper has been studied under widely different conditions. The rate of strain has been varied by a factor of more than $10^6$. In the most rapid experiments, the paper breaks within a msec. The slowest experiment requires several days. The behaviour of paper in rapid and slow straining processes is different and so are the changes brought about in the material by the straining processes. This is shown, for example, by comparison of stress-strain curves and paper strained twice, first slowly and then rapidly and vice versa. The ultimate tensile strength increases very markedly in the rapid experiments, but the relative increase is also a function of the fibre composition of the paper. Extensibility is not affected very much by the rate of straining. From the stress-strain curves several properties of the paper may be evaluated, e.g. the initial and ultimate modulus of elasticity and thixotropic changes brought about by repeated cycles of straining. The plastic properties of the material are given by tracing apparent viscosity curves. Special attention is given to stress-relaxation of paper under constant deformation. This property may be very different for different papers. Some papers strained rapidly (0·001 sec) will, while held under constant strain, relax extremely slowly and never completely. Others, strained to the same extent, will dissipate the energy completely in as short a time as 0·01 sec. BRITISH RHEOLOGISTS' CLUB

539.32

**5341. Young's modulus as a function of wire diameter.** G. C. Kuczynski. Letter in *Nature, Lond.*, **165**, 562–3 (*April* 8, 1950).

539.3

**5342. Internal friction of metals at very hig temperatures.** T.-S. Kê. *J. Appl. Phys.*, **21**, 414– (*May*, 1950).

In connection with the study of the internal frictio peak (*v.* temperature) associated with the viscou behaviour of grain boundaries in metals, some oth effects were observed at higher temperatures causin an additional internal friction, due to effects of colo working in the interior of the grains which rema even after complete recrystallization. It increase with the amount of cold-work the specimen wa subjected to before and after recrystallization; decreases with annealing at successively highe temperatures until a stable value is reached; and i increases with the precipitated impurity content in th specimen. It was found to be very high in an age specimen of high purity Al alloyed with 4% of Cu These observations are consistent with the viewpoin that this internal friction is caused by the presence c dislocations in the interior of the specimen althoug the mechanism of giving rise to the internal frictio is unknown. It is pointed out that a study of hig temperature creep under very low stress may b conveniently carried out through the internal frictio measurements described. A

539.32 : 534.321.9 : 535.8

**5343. Measurement of elastic constants of optica glass from diffraction patterns of glass cubes vibratin at high frequencies.** C. Schaefer and L. Bergmann *Ann. Phys., Lpz.*, **3**, 72–6 (1948) *In German.*

A beam of polarized monochromatic light is passed through a very fine slit and a $\lambda/4$ plate and then traverses a cube of glass which is vibrated at a frequency between 3·5 and 15 Mc/s; it next passes through a Nicol prism analyser and is finally brought to a focus on a photographic film. Diffraction patterns (or elastograms) are obtained consisting of 2 rings of discrete points. The outer ring corresponds to the transverse waves in the glass and the inner ring to the longitudinal waves. The ratio of the diameters of the rings gives directly the Poisson ratio of the glass and, from a knowledge of the density of the glass, the frequency of vibration and the constants of the apparatus, the elastic and torsional moduli can be calculated. The definition of the rings can be improved by rotating the Nicol prism and an accuracy of ± 1% is claimed in measuring the diameters. The elastic constants of 155 Schott glasses are given. H. J. H. STARKS

539.32 : 539.42

**5344. A bending method for measurement of the tensile strength and Young's modulus of glass fibers.** D. Sinclair. *J. Appl. Phys.*, **21**, 380–6 (*May*, 1950).

The method consists of twisting a loop in a fibre and pulling the ends until the loop breaks. The tensile strength observed by this method was 2–3 times > observed by the conventional straight fibre method, while Young's modulus was practically unchanged. These results may be accounted for by the presence of flaws, since the probability is small that the weakest flaw will occur in the loop, while the straight fibre will always break at the weakest flaw. The apparatus used, a modified Chainomatic balance,

escribed and the equation of the looped fibre is ved. The method is used to measure the maximum ile stress and strain attained at the point of imum radius of curvature of the loop as well as breaking tensile stress and strain at the actual k point. The stress at the break point was found e as small as one-half the maximum attained in loop, showing that the strength of the fibre was uniform. A.

539.37

**5. On the theory of infinitesimal deformations.** YANO. *J. Fac. Sci. Tokyo Univ.*, **6** (*Pt* 1) 1–75 9) *In French.*

survey of the theory of the deformation of an e *n*-space, and the deformation of a sub-space n affine space. References. J. G. OLDROYD

539.37

**6. Atomic displacements associated with elasy in plastically deformed metals.** W. A. WOOD N. DEWSNAP. *J. Inst. Met.*, **17**, 65–78 (*March*, 0).

etermination by the X-ray diffraction method been made of the magnitude of the internal sses developed between the grains during the plastic rmation of tensile specimens of Fe and Al. It is nd that in fine-grained specimens the magnitude he stresses tends to increase in a regular manner n deformation up to a maximum value comparable n the ultimate stress of the material. But as the n-size becomes coarser and of the same order of as the section of the test-piece, the intergranular sses become irregular both in magnitude and ction, and also tend to be smaller. A tentative gestion is made regarding a mechanism by which intergranular stresses could arise, otherwise than the previously recognized mechanism which ibutes the stresses to mechanical anisotropy of the al grain. A.

539.37

**7. Theory of elasticity in general coordinates.** E. GREEN AND W. ZERNA. *Phil. Mag.*, **41**, 313–36 *ril*, 1950).

he theory of stresses and finite strains in an tic body is developed, using the notation of tensor ulus. A curvilinear co-ordinate system is used ch moves and deforms continuously with the ly. Stress-strain relations for isothermal and for abatic changes are derived from virtual work siderations, without assuming isotropy of the erial. Equations of compatibility for the coments of strain are also derived. J. G. OLDROYD

539.371

**8. Large elastic deformation of rubber.** R. KUBO. *Phys. Soc. Japan*, **3**, 312–17 (*Sept.–Dec.*, 1948).

539.371 : 539.6

**9. Investigations on the role of intermolecular es in the mechanics of high-elastic deformations. Molecular mechanisms and the equations of the etics of high-elastic deformations** B. A. DOGADKIN, M. BARTENEV AND M. M. REZNIKOVSKIĬ. *Koll. Zh.*, 314 (1949).

Relaxation times for rubber at various temperatures are calculated from a somewhat modified Maxwell equation and their logs. are found to be linearly related to the square of the "non-equilibrium" part of the strain. BRITISH RHEOLOGISTS' CLUB

539.373 : 548.24

**5350. On the liability to slip of metallic structure of the magnesium group** H. SEIFERT. *Ann. Phys., Lpz.*, **6**, 10–17 (1949) *In German.*

A study has been made of glide elements in the case of simple slip (twinning glide) in metals of the Mg group, to see whether the formal geometrical laws are obeyed. The importance of complicated secondary structural elements, as respects the lattice planes and lines, has been proved. The occurrence and position of the nodes of maximum electron density determine the real glide elements. Mechanical twin formation along the plane $10\bar{1}2$ in the Mg group was analysed kinematically. G. O. BAINES

539.374

**5351. On the duration of the viscoplastic flow of a substance after an impulsive load.** P. M. OGIBALOV. *Uchen. Zap. Mosk. Gos. Univ. Mekh.*, **122** (*No. II*), 183–92 (1948) *In Russian.*

539.374

**5352. Flow of plastic materials.** F. CHARRON. *C.R. Acad. Sci., Paris*, **230**, 614–15 (*Feb.* 13, 1950) *In French.*

A simple expression is derived from the Buckingham–Reiner equation for the flow of a plastic material through a tube of circular section at stresses near to the yield stress. J. E. CAFFYN

539.374

**5353. On plastic flow and vibrations.** C. J. THORNE. *J. Appl. Mech.*, **17**, 84–90 (*March*, 1950).

A general solution is given for the behaviour in the linear case of a mechanical model proposed and used by Eyring and others. 4 examples are worked in detail. In particular, the steady-state solution for the deflection in periodic vibrations is given in terms of the material constants for any frequency. The transients are given in detail for the 3 possible cases and inequalities are given to determine which case a particular problem is. A.

539.374

**5354. Relaxation methods applied to problems of plastic flow. I. Notched bar under tension.** J. A. JACOBS. *Phil. Mag.*, **41**, 349–61 (*April*, 1950).

539.375

**5355. A proposal of a new theory concerning the yielding of materials based on Riemannian geometry. II.** K. KONDO. *J. Soc. Appl. Mech. Japan*, **2** (*No.* 12) 146–51 (1949).

A continuation of earlier work [Abstr. 2939, 3436 (1950)]. J. G. OLDROYD

539.378.6

**5356. Crushing of single particles of crystalline quartz. Application of slow compression.** J. W. AXELSON AND E. L. PIRET. *Industr. Engng Chem.*, **42**, 665–70 (*April*, 1950).

Single particles of crystalline quartz weighing 1 to 2 g were crushed in a steel mortar by means of slow compression. The energy input was calculated from force

and displacement measurements and the surface areas of the original sample and the crushed product were determined by gas adsorption. In the 17 experiments performed the average energy concentration at fracture ranged from 0·3 to 44·6 kg-cm/g. The new surface formed per unit of energy input ranged from 17 to 265 cm²/kg-cm. A curved relationship was found between the new surface formed per unit of energy input and the energy concentration at fracture. Using 980 ergs/cm² as the surface energy of quartz, the efficiency of crushing single particles of quartz ranged from 26·5 to 1·7% with an average value of 9·4%. This compares with 1·4% for the efficiency of crushing multiple particles of the same type of quartz by the same method. Hypotheses are advanced to explain the results. A.

539.4.016.2 : 539.215.2 : 539.26

**Effect of plastic deformation on diffuse X-ray scattering.** *See Abstr.* 5330

539.434

**5357. The creep of glass at high temperatures.** C. Crussard. *Sheet Metal Ind.*, **25**, 2471 (1948).

Pyrex glass was used and testing was carried out in (1) the quenched state, and (2) when annealed and slowly cooled; tests were made at 420° and 500°C with loads varying from 150 to 1 580 g/mm². The results show an instantaneous elongation followed by transient creep, after which the creep rate becomes constant. On loading, the instantaneous contraction is almost equal to the initial elongation and is followed by marked creep recovery, the deformation being almost reversible. Consideration of the variations in instantaneous length indicates that the instantaneous deformation is not purely elastic. Creep was found to be more rapid for the quenched state; the abnormal creep found in the annealed state is reversible. In the second stage of creep only does the glass behave like a viscous liquid.

BRITISH RHEOLOGISTS' CLUB

539.434

**5358. Metallic creep and creep resistant alloys.** A. H. Sully. *London, Butterworths Scientific Publications; New York, Interscience Publishers* (1949) 278 *pp.*

The book attempts to present the viewpoint of both the industrial and academic worker in discussing creep, the time dependent part of the deformation accompanying the application of stress to a solid. There are chapters on the measurement of creep, discussing apparatus, experimental conditions and various creep tests; characteristics of creep curves, dealing with transient and quasi-viscous creep, short-term tests, creep limit, fracture and microcreep; characteristics of deformation and physical theories of creep; metallurgical factors affecting creep, such as crystal size, prior strain, impurities and alloying, heat treatment and environment; creep properties of both ferrous and non-ferrous alloys; and the development of creep resistant alloys. An Appendix contains the recommendations of the British Standard Institution (A.23) and the A.S.T.M. for procedures for conducting creep tests. The book is fully furnished with illustrations, tables of data and lists of references. E. P. WOHLFARTH

539.

**5359. Diffusional viscosity of a polycrystalline so** C. Herring. *J. Appl. Phys.*, **21**, 437–45 (*M* 1950).

According to a suggestion of Nabarro, any cry can change its shape by self-diffusion in such v as to yield to an applied shearing stress, and this cause the macroscopic behaviour of a polycrystall solid to be like that of a viscous fluid. It is possi that this phenomenon is the predominant cause creep at very high temperatures and very low stress though not under more usual conditions. The the underlying it is developed quantitatively, and culations of rate of creep, or equivalently of effect viscosity, are given for aggregates of quasi-spheri grains and for wires composed of cylindrical grai Allowance is made for the effect of tangential str relaxation at the grain boundaries. It is suggest that mosaic boundaries and boundaries betwe grains of nearly the same orientation may be una to serve as sources or sinks of the diffusion curre in which case the creep rate will depend only on t configuration of grain boundaries having a sizab orientation difference. Numerical comparison of t theory with experiments on the high temperatu creep of wires favours this view, but is not entire satisfactory. Suggestions for further experiments a made.

539.5

**5360. The rheology of paper. I. The practic significance of paper rheology.** B. Steenberg. *Pa Mkr*, **118** (*No.* 4) 258 (1949).

539.5

**5361. The rheology of paper: III. Graphic analysis of stress/strain curves for paper.** O. Ander son, B. Ivarsson, A. H. Nissan and B. Steenber *Pap. Mkr*, **118** (*No.* 5) 335, (1949).

The stress-strain curves are analysed in terms of three-element model consisting of a Maxwell eleme in parallel with a spring. Some of the practic applications of the results are discussed.

BRITISH RHEOLOGISTS' CLU

539.5

**5362. The temperature-dependence of the form the flow curves of non-Newtonian compounds and i relation to the transition point.** W. Scheele an T. Timm. Letter in *Z. Naturforsch.*, **4a**, 639–4 (*Nov.*, 1949) *In German.*

The observed relation $v = K\tau^n$ [see Abstr. 221 (1950)] relating the linear flow $v$ and shear stress has been investigated at different temperature Curves for a specimen of polyvinylacetate are repro duced to illustrate that $n$ has a max., and $K$ a min value at a certain temperature (~ 60°c), at which th graph of log ("deformation-power") [see Abstr. 66 (1945)] against 1/(absolute temperature) has a dis continuity in slope. Experimental proof is sti required that this temperature is related to th transition point in the volume-temperature curve.

J. G. OLDROY

539.5

**5363. Rheology of hydrocarbon gels.** K. Weissen berg. *Proc. Roy. Soc. A*, **200**, 183–8 (*Jan.* 6, 1950)

539.501

**Note on the rheological properties of elasto-ic materials.** K. GOLDSMITH. *Brit. J. Appl.* , **1**, 107–9 (*April*, 1950).

is shown that the flow properties of some elasto-ic materials can be expressed by an empirical tion. 3 constants, derived from this equation, measure of these properties. A.

539.501

**. The rheology of unseasoned linoleum.** A. G. D. *Brit. J. Appl. Phys.*, **1**, 113–18 (*May*, 1950).

n extrusion method for the measurement of the properties of unseasoned linoleum is described. method is suitable either for the study of absolute properties, or for routine testing, and examples application are given. A.

539.621

**. The static coefficient of friction and the area ntact.** R. C. PARKER AND D. HATCH. *Proc. Soc., Lond. A*, **63**, 185–97 (*March*, 1950).

n apparatus for measuring the static coefficient iction has been designed in which the forces ing to disturb the contact area are minimized which further enables the contact area to be ed throughout the experiment. Application of a ential load, less than that required to give ing friction, has been shown to give rise to a th of both the real and apparent contact areas to produce a relative displacement of the surfaces to an extent governed by the tangential load. An examination of the surface topography, by means of an electron microscope, has shown that the earlier type of slip ceases because surface scratches extend the boundaries of real contact. Both the force of adhesion and the tangential force vary linearly with the real and apparent areas of contact. These results are in accord with a cohesive theory of friction, and offer no support for the theory on which friction is attributed to the formation of welded junctions. A.

539.89

**5367. Effect of hydrostatic pressure on plasticity and strength.** P. W. BRIDGMAN. *Research, Lond.*, **2**, 550–5 (*Dec.*, 1949).

The results of experiments on the plasticity and strength of various materials, metals and non-metals, under hydrostatic pressures up to 450 000 lb/in² are described. Under such pressures it appears that the ductility and breaking strain, etc., are considerably increased, even brittle materials such as phosphor bronze showing remarkable ductility. Further, the breaking strains of various materials can be artificially increased by previously pulling them under very high pressures. Shearing experiments at pressures up to 750 000 lb/sq in are also described, the distortions produced being so large that in some instances chemical rearrangements were produced. The application of the results to geological problems of conditions deep in the earth's crust is suggested.

T. C. TOYE

# PHYSICAL CHEMISTRY 541

## PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123.28

**. Studies of gas absorption. VI. A graphical esentation for the efficiency of physical absorption.** N. VAN KREVELEN. *Rec. Trav. Chim. Pays-Bas*, 03–8 (*March*, 1950).

quations for the absorption rate coefficient and efficiency of absorption are derived. A graph is n by which the application of these relationships nsiderably simplified. A.

541.124

**. Molecular diameters in chemical kinetics.** CARERI. *Atti Accad. Naz. Lincei* (*R.C. Cl. Sci. Mat. Nat.*), **7**, 232–40 (*Nov.*, 1949) *In Italian.*

is pointed out that it is not legitimate to use the ecular radii given by the kinetic theory of gases in r to calculate the effective cross-section in nical reactions. The use of this model is shown to velocities of reaction respectively in defect or in ss by a factor of 3–4 for impacts of the first or of second kind. Approximate criteria are given for calculation of the effective cross-section. It was ossible to verify these criteria in the case of impacts ne first kind, but they are shown to clarify the tics of certain reactions (e.g. between alkalis and gens) involving impacts of the second kind.

L. PINCHERLE

541.124.7

**5370. Calculation of the dissociation-equilibrium of a mixture of the di-atomic compounds $H_2$, $C_2$, $N_2$, CH, NH, CN, with comparable abundances of the elements H, N and C.** W. LEHMANN. *Z. Astrophys.*, **26** (*No.* 2–3) 334–40 (1949) *In German.*

This study of the dissociation equilibrium leads to a system of quadratic equations which are solved simultaneously and with sufficient accuracy for practical purposes by a suggested method of successive approximations. A numerical example is treated in detail. A. BEER

541.126 : 534.222.2

**5371. The state of a detonating explosive and the velocity of the ejected gases.** C. H. JOHANSSON. *Ark. Fys.*, **1**, *Paper* 29, 563–7 (1950).

The velocity of the air-shock wave from the flat end of a cylindrical stick of explosive was measured by means of a rotating-mirror camera with a writing speed of 0·9 mm/$\mu$sec. The detonation velocity of the explosive used (a cast mixture of 60% PETN and 40% TNT) was 7 400 m/sec. It was found that the air-shock velocity 2 cm from the explosive face is 6 500 m/s at normal atmospheric pressure, and increases as the air-pressure decreases, reaching 17 500 m/s at 0·5 mm Hg. The high velocity of the shock wave when the air pressure is low may, it is suggested, be due to the existence of a thin layer of gas at the detonation front in which the particle

velocity is ≫ that of the main body of gas behind the detonation wave. A. SCHOFIELD

541.126 : 534.222.2

**The formation of a blast wave by a very intense explosion.** *See Abstr.* 4777

## ELECTROCHEMISTRY 541.13

541.13 : 621.351

**5372. Direct conversion of chemical energy of fuel into electrical energy.** O. K. DAVTYAN. English Abstr. in *Rep. Brit. Elect. Res. Ass.* (*Ref. Z/T76*) 18 *pp.* (1949) *In Russian.*

The importance of the fuel cell problem is discussed and a review of its history is given; an efficiency of 99·75% is claimed for a carbon-oxygen cell. Thermodynamic calculations for free energy and e.m.f. at various operating temperatures are given for the cells: hydrogen–oxygen, carbon–oxygen (1), (oxidation to CO), carbon–oxygen (2), (oxidation to $CO_2$), and carbon monoxide–oxygen. A connection is shown between the over-voltage of various metallic electrodes and their behaviour as gas electrodes. A hydrogen cell with air depolarization is described. Important advances are reported for fuel cells operating at room temperature with hydrogen, and, at high temperatures (550–900°), with producer gas as fuel. Difficulties attending the development of gas cells with solid electrolytes are discussed with examples of suitable substances on the basis of combinations of sodium carbonate, tungsten oxide, calcium oxide, quartz, etc. H. H. HODGSON (R)

541.133

**5373. Measurements of conductivity at high frequencies. II.** A. CARRELLI AND L. RESCIGNO. *Nuovo Cim.*, **7**, 9–12 (*Jan.*, 1950) *In Italian.*

Results are given for KCl in glycerine-water and glucose-water mixtures at $\omega \sim 0$ and $\omega \sim 4{\cdot}47 \times 10^7$ $sec^{-1}$.

541.133

**5374. Space charge in electrolytes.** A. R. GORDON. Letter in *J. Chem. Phys.*, **18**, 146 (*Jan.*, 1950).

The work of Reed and Schriever [Abstr. 2751 (1950)] who reported that a space charge exists in a column of electrolyte during electrolysis, and hence Ohm's law does not apply is criticized on the grounds that (1) the two liquid electrode potentials must be equal and opposite; (2) "hard" metals are erratic in behaviour and the "chemical potential" between a probe and a current electrode may not be the same when the current is passing and when it is not; (3) electrode overvoltage was ignored; this depends in a complicated way on the nature of the surface; (4) no account was taken of concentration changes in solution due to the electrode processes, migration and diffusion; (5) the slow changes of potential with time are more likely to be due to slow processes such as migration and diffusion than to an electrostatic effect. A. J. MEE

541

**5375. Reply to "Space charge in electrolyt** W. SCHRIEVER. Letter in *J. Chem. Phys.*, **18**, 14 (*Jan.*, 1950).

The apparatus used by Gordon was such appreciable space-charge effects probably ne reached to the part of the cell between the poter probes. The chemical potential if it existed wo produce the same effect throughout a given test would not affect the shape and curvature of deviation-time curve, and therefore the calcula potential gradient and space-charge distributi would be unaffected. It is denied that over-volt and other near-electrode effects were ignored.

A. J. I

541.13

**5376. Anomalous $H^+$ and $OH^-$ ion mobility water.** A. GIERER AND K. WIRTZ. *Ann. Phys.*, *L* **6**, 257–304 (1949) *In German.*

541.13

**5377. Studies with space electrodes.** W. RÜE *Diss. E.T.H. Zürich*, 81 *pp.* (1949) *In German.*

Porous electrodes have been examined and effect of various organic liquids used as depolariz has been investigated. The special use of this type cell for the reduction of sparingly soluble substan is pointed out. Coulometric methods of analysis ha been carried out with a cell with this type of electro using $HgCl_2$ as depolarizer. The connections betwe electrode potential, resistance, current strength a temperature have been investigated. A method the mathematical formulation of the polarizati current curve is considered. A. J. M

541.13

**5378. Measuring electrodes for use in the s** A. T. MIRONOV. *Dokl. Akad. Nauk, SSSR*, **70** (*No.* 825–7 (1950) *In Russian.*

## PHOTOCHEMISTRY RADIATION CHEMISTRY 541.14

541.

**5379. Chemical effects of nuclear recoil.** A. MADDOCK. *Research, Lond.*, **2**, 556–63 (*Dec.*, 194

Summarizes present knowledge of chemical r actions initiated by recoil atoms in various types nuclear transformations. Results of calculations the recoil energy both for heavy particle emission capture and for $\beta$-particle decay are indicated. Th chemical effects produced by nuclear reactio involving heavy particles are described and it shown that though the recoil energy might be expect to effect complete destruction of all molecules co taining the disintegrating atoms an appreciab proportion of the transformations lead to t reformation of the parent or similar compounds b secondary reactions. The chemical effects produce by recoil from photon emission following neutro capture are of importance in enabling a number c separations of some nuclides of high specific activit (Szilard–Chalmers reaction). Investigations of th

have been most important in the alkyl halides in the oxyanions. A good bibliography is ded. H. MILLER

541.14

**On the fluctuating concentration of X-ray icts in water dispersions.** F. H. KRENZ. *Proc. Soc., Lond. B*, **63**, 297–9 (*April*, 1950).

has been found that the partial pressure of mposition gases over water irradiated with X-rays iates more or less regularly with the irradiation The experiments suggest that the fluctuations aused by impurities in the water, and that this omenon is possibly related to the periodic rise fall of electrophoretic mobility observed in the of certain colloids when these are subjected to adiation. A.

541.14 : 539.164

**On the kinetics of the exchange reaction een hydrogen and deuterium under the action of a rays.** W. MUND AND M. VAN MEERSCHE. *Acad. Roy. Belg. Cl. Sci.*, **36** (*No.* 1) 47–62 0) *In French.*

541.14 : 539.164

**The solids condensed from carbon monoxide pha particles.** J. H. L. WATSON, M. VANPEE AND LIND. *J. Phys. Coll. Chem.*, **54**, 391–401 (*March*, ).

541.14 : 539.164.9

**Radiochemical yield of the ultra-violet sion in a gas traversed by α-particles.** S. MEAU. *C.R. Acad. Sci., Paris*, **230**, 956–7 (*March* 50) *In French.*

he ratio of the number of u.v. photons emitted by o the number of ion-pairs produced by a Po ce of α-rays placed in the gas was determined. total number of photons emitted per min by the was $8\times10^7$ to $10^8$, and the number of ion pairs $6\times10^{14}$. The radiochemical yield is therefore een $10^{-7}$ and $2\times10^{-7}$. A. J. MEE

541.14 : 539.172.4

**Exchange reactions in $(n, \gamma)$ nuclear trans-ations.** A. S. KARAMYAN. *Dokl. Akad. Nauk, R*, **69** (*No.* 6) 787–8 (1949) *In Russian.*

ie Szillard–Chalmers reaction was investigated the methyl-bromide series, $CH_3Br$ to $C_6H_{13}Br$. incomplete separation of activated Br is attributed combination. E. P. GEORGE

541.14 : 539.185.9

**Molecules formed after irradiation of organic ides with neutrons.** P. SUE AND A. NOUAILLE. *Acad. Sci., Paris*, **230**, 954–6 (*March* 6, 1950) *In ch.*

hen compounds such as $C_2H_5Br$ and $C_2H_4Br_2$ irradiated with neutrons it would be expected after the loss of radioactive Br, some reactions ld occur between the free radicals produced. e reactions could give rise to new compounds aining radioactive Br, which would be present in nedium. To investigate the occurrence of such no-derivatives efforts have been made to separate n by distillation using an inseparable mixture of ocarbons (chain length $C_6$ to $C_{14}$) as a continuous er. This distils between 30° and 180°C. The presence of $CH_2Br_2$ and of $(CH_2Br)_2$ in the products of irradiation of $C_2H_5Br$ has been demonstrated. In the case of irradiation of $C_2H_4Br_2$, $CH_2Br_2$ and $(CHBr_2)_2$ were found. A. J. MEE

## DISPERSIONS . COLLOIDS ADSORPTION 541.18

541.182.3

**5386. Techniques for generating silver iodide smoke.** B. VONNEGUT. *J. Coll. Sci.*, **5**, 37–48 (*Feb.*, 1950).

Generators are described which are capable of producing large numbers of AgI smoke particles for nucleating natural clouds. These generators are of two kinds, the charcoal-burning type and the spray-nozzle type. The charcoal-burning generator produces AgI smokes by burning wood charcoal which has been impregnated with AgI. The spray-nozzle generator produces smokes by burning AgI solution atomized from a small spray nozzle with compressed H. The construction and operation of these smoke generators is described. In addition, a larger generator employing a turbo-jet burner is described. The preparation of the AgI solutions used in these smoke generators is outlined. A.

541.182.4

**5387. Theory of the electric double layer of stabilized emulsions.** E. J. W. VERWEY. *Proc. K. Ned. Akad. Wet.*, **53** (*No.* 3) 376–85 (1950).

541.182.5

**5388. A discussion on the physics and chemistry of hydrocarbon gels.** E. K. RIDEAL *et al. Proc. Roy. Soc. A*, **200**, 136–91 (*Jan.* 6, 1950).

Symposium of 10 papers, for 3 of which see Abstr. 2052, 2942, 3424 (1950).

541.182.7 : 532.78

**X-ray diffraction by aqueous systems of tri-ethanolamine laurate.** *See Abstr.* 4761

541.183 : 538.22

**5389. Magnetic measurements applied to adsorption.** C. COURTY. *C.R. Acad. Sci., Paris*, **230**, 745–7 (*Feb.* 20, 1950) *In French.*

Magnetic measurements of air and water adsorbed on carbon black, which have been published in a long series of papers [*ibid.*, 1942–1947], may have appeared to contradict, in the case of adsorption, the law of additivity of magnetic constants. However, if the appropriate corrections are made in the calculation of susceptibility it is shown that the law still holds. Two such corrections which it is necessary to apply in the case of the measurement of magnetic susceptibility of adsorbed air and water are as follows: (1) the amount of air displaced by water must be taken into account; (2) the possible formation of CO must be considered. Two typical calculations are given to illustrate the effect of the corrections. J. IBALL

541.183.3

**5390. The adsorption of vapours on mercury. IV. Surface potentials and chemisorption.** C. KEMBALL. *Proc. Roy. Soc. A*, **201**, 377–91 (*April* 26, 1950).

## CHEMICAL ANALYSIS 543/545

545.8 : 539.185

**5391. Neutron spectroscopy for chemical analysis. II.** W. W. Havens, Jr. and T. I. Taylor. *Nucleonics*, **6**, 66–77 (*Feb.*, 1950).

Total cross-section of an element can be determined as a function of energy, by measuring transmission of neutrons in a narrow energy range selected by means of a crystal spectrometer or velocity selector. The method of determining the amount of an impurity in an element, when the impurity has a promin resonance peak in a region where the pure elem has none, is outlined and examples are given of application of the method to the detection of In Sn and Hf in Zr. The sensitivity of the method discussed. The analysis of binary systems fr transmission measurements in the $1/v$ region is a described. L. R. SHEPHE

545.824 : 535.3 : 537.5

**Quantitative X-ray absorption analysis with ionization spectrometer.** *See Abstr.* 5020

# CRYSTALLOGRAPHY 548

548.0 : 537.228 : 535.37

**Modification of the properties of crystals by an alternating electric field.** *See Abstr.* 4859

548.1

**5392. Affine lattice constants.** N. N. Padurow. *Acta Cryst.*, **3** (*No.* 3) 200–3 (1950) *In German.*

These are a set of 6 constants, 5 of them angular and one linear. The former characterize extensions and shears by which the general, i.e. triclinic, crystal cell may be deformed into a cubic cell, and the linear constant gives the absolute length of the edge of this cube. 2 of the 5 angles used coincide with angles introduced by Fedorow. 2 angular constants may be interpreted as the 2 extensions required to transform an orthogonal cell of volume equal to that of the crystal cell into a cube without changing the length of the edge; this length being the linear constant. The 3 other angular constants are the shear angles by which the triclinic cell may be made orthogonal without change of volume. Formulae are given for the various crystal systems for transforming the usual axial constants (3 lengths, 3 angles) into the affine constants, and vice versa. A.

548.52 : 539.215.2

**5393. The orientation dependence of the rate of grain boundary migration.** P. A. Beck, P. R. Sperry and Hsun Hu. *J. Appl. Phys.*, **21**, 420–5 (*May*, 1950).

Very small recrystallized grains of a large variety of orientations were produced locally in lightly rolled high purity Al crystals. The rate of growth of these small grains varied greatly, depending on their relative orientation with respect to the matrix crystal. Grains with an orientation corresponding to a [111] rotation of about 40° showed by far the highest rate of growth. These results indicate that recrystallization textures developing in the spontaneous recrystallization of deformed single crystals can be accounted for by the orientation dependence of the rate of growth. A.

548.55 : 536.413.2

**5394. The preparation of metal single crystals for expansion measurements.** B. G. Childs. *J. Sci. Instrum.*, **27**, 102–3 (*April*, 1950).

A description is given of the method used to convert a single crystal of Sn into spacers, free from strain and recrystallization, for use in an interferometric dilatometer. 3 or more pieces, 8 mm long, were cut from a crystal, their ends sharpened and their lengths made equal to within $3\mu$. The measured line expansion coefficients of 6 crystals of various angl $\theta$, of orientation are shown plotted against cos and no scatter of the experimental points attributat to recrystallization is evident.

## MOLECULAR AND X-RAY CRYSTALLOGRAPHY 548.7

548.7 : 537.2

**5395. Ionic polarisation in crystals: additivity double salts.** D. A. A. S. Narayana Rao. *Pro Indian Acad. Sci. A*, **30**, 317–19 (*Dec.*, 1949).

The electronic and the ionic polarizations a calculated for a number of hydrated salts, in t hydrated and anhydrous conditions, for zirco $(ZrO_2SiO_2)$, spinel $(MgOAl_2O_3)$ and dolomi $[CaMg(CO_3)_2]$ and for the constituent substances the latter 3 compounds. It is shown that in all the compounds the electronic and ionic polarizations a nearly the sums respectively of the electronic an ionic polarizations of the constituent molecul separately considered. The probable reasons for t small departures from additivity are discussed.

548.73

**5396. Single crystal X-ray techniques for use wi alloys requiring protective atmospheres.** J. Singe and F. H. Ellinger. Letter in *J. Appl. Phys.*, 2 467–8 (*May*, 1950).

548.734 : 518.

**5397. The use of "Hollerith" computing equipme in crystal-structure analysis.** E. G. Cox and G. A Jeffrey. *Acta Cryst.*, **2**, 341–3 (*Dec.*, 1949).

The Hollerith punched-card system of computin is briefly described from the point of view of the X-ra structure analyst. The principal differences betwee American and British equipment are described an technical terms in common use are explained. A

548.736.3 : 536.42

**X-ray and thermal studies on the phase transition of cuprous sulphide $Cu_2S$.** *See Abstr.* 4919

548.74 : 537.533.7

**Anomalies of small angle reflection of cathode ray from the surface of a single crystal.** *See Abstr.* 5033

548.74 : 537.533.73

**the theory of Kikuchi bands.** *See Abstr.*

548.74 : 539.23

**Electronographic investigation of films of polyvinyl alcohol. I.** *See Abstr.* 5324

# BIOLOGY 57/59

578 : 621.395.645

**Design and applications of the electro-halograph. I–III.** H. G. GIBSON AND V. F. ...OLD. *Marconi Instrum.*, **1**, 119–25 (*Nov.–Dec.*, ...; **2**, 12–15 (*March–April*); 24–7 (*May–June*, 1949). ...tlines the physiological aspects of e.e.g. work ...applications to epilepsy, tumours, meningitis, ...halitis, etc. A typical instrument has a stabi- ...power supply, multi-channel amplifiers of ...about $10^7$ and l.f. response down to 0·35 c/s, ...pen recorders; but special techniques must be ...oyed. Amplifiers are balanced throughout with ...rejection of in-phase signals due to hum and stray ...up—suitable circuits are analysed—and the ...ng iron recorder is of robust construction, ink ...ng on ordinary paper. A systematic routine is ...sary in the use of the instrument to achieve ...ant results capable of medical interpretation and ...oid artifacts due to mains interference, muscle ...ty, loose contacts, eye movements, sweating and ... sway. Typical 4-channel artifact records are ...rated. Electro-cardiography and -myography ...lso possible. E. D. HART (R)

578 : 621.396.615.17

**A new electrical discharge circuit for neuro-...ular studies.** E. C. LEISEGANG AND S. H. RIPLEY. ...*r. J. Sci.*, **46**, 124–5 (*Nov.*, 1949).

...e requirements for these studies, which the ...it meets, are: (1) rectangular wave shape; ...ecurrence frequency variable from 1 to 500 c/s; ...ulse length and amplitude variable over ranges of ...msec and 0–50 V respectively; and (4) absence ...teraction between frequency, pulse length and ...itude. The sawtooth voltage output from a ...be discharge circuit is differentiated and the ...ing negative "pips" squared by a sharp cut-off ...$\mu$ pentode. The output is RC-coupled, through ...d-limiting resistor to ensure rectilinearity, to an ...ut valve. Here, a variable cathode resistor is ...ded to enable a d.c. component to be included ...e output. It is claimed that, because of the good ...inearity of the pulse, the pulse length can be ...directly off the resistance value of the variable ...or in the differentiating network.

H. G. M. SPRATT (R)

578.088.7 : 621.389 : 621.318.572

**An electronic trigger circuit as an aid to ...physiological research.** H. W. SHIPTON. *J. Brit. ... Radio Engrs*, **9**, 374–83 (*Oct.*, 1949).

...e electroencephalograms (e.e.g.) of epileptics and ...cts having tumours or psychological disorders ...frequently characterized by the presence of ...ic patterns, known as wave and spike, or ...ms of 1–3 or 4–7 c/s. The "wave and spike" ...ot always shown, while the rhythms can be ...n by other random potential changes, but they ...ometimes be induced or, if already existing at a low level, amplified by visual stimuli such as flashing lamps, particularly if the flash rate is of the correct frequency. The provision of pos. feedback from the e.e.g. output to the triggering circuit of the stimulating source can provide automatically this correct frequency and so reveal latent rhythms. Pos. or neg. output from the e.e.g. amplifier is applied to a cathode follower, either directly if adequate, or through a variable resonant amplifier of the RC-coupled type. In the cathode circuit of the cathode follower is a high-speed relay, the contacts of which open and close a −70 V supply and thus provide, through a differentiating network and a diode, neg. pulses for controlling a pentode triggering valve. This valve drives a high-power stroboscopic light source used as the stimulus. Controllable delay is provided in the triggering circuit. The subjective effect of this rhythmic stimulation on normal or near-normal patients is discussed. H. G. M. SPRATT (R)

## MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

614.8 : 539.163

**5401. Radioactive waste disposal—how will it affect man's economy?** K. G. SCOTT. *Nucleonics*, **6**, 18–25 (*Jan.*, 1950).

The health hazards arising from the contamination of public sewage systems by radioactive waste are described and the need for storage of such waste to allow the activity to decay to a safe level is emphasized. Disposal of radioactive waste products in the ocean may be safe if dilution is sufficiently rapid, but biological accumulation of longer lived activities may interfere with the economic usefulness of regions in which waste is disseminated. L. R. SHEPHERD

614.8 : 539.166

**Concrete as a protective barrier for gamma rays from cobalt 60.** *See Abstr.* 5250

615.849 : 537.533

**5402. Possible techniques in direct-electron-beam tumor therapy.** W. H. BOSTICK. Letter in *Phys. Rev.*, **77**, 564–5 (*Feb.* 15, 1950).

615.849 : 621.386.1

**5403. An X-ray apparatus for therapeutic treatments.** B. COMBEE AND J. FRANSEN. *Philips Tech. Rev.*, **11**, 193–205 (*Jan.*, 1950).

A description of the "Compactix" apparatus for X-ray therapy, which works with alternating voltages up to 200 $kV_{max}$ and a tube current up to 10 mA. The h.v. generator is mounted together with the X-ray tube in a cylindrical tank 1·20 m long and weighing 125 kg (275 lb). The tank is mounted on a stand which permits 5 degrees of freedom of movement and is easy to adjust for any type of treatment.

Constructional features are: separation of the h.v. transformer into two units for 100 kV placed at either end of the X-ray tube, so that the focus of the tube lies in the centre of gravity of the tank; there are three separate compartments in the tank, for the tube and the two transformers; the tube is insulated and cooled with freely circulating oil; the operator is fully protected against X-rays outside the effective applicator by a tungsten hood on the anode and a layer of lead 1 mm thick in the shield, with a total lead equivalent of 5 mm lead; h.v. transformer supply with "inverse voltage suppression"; tube-voltage measuring with automatic correction for the eff of the tube current; stabilization of tube current a tube voltage within about 1%, with special regulat circuits directly controlled by the current or voltage; on the control desk, in addition to the norm current and voltage regulators, there are three k for selecting three standard ray qualities, and signall of the filter in use. The max. half-value layer obtain with a tube voltage of 200 $kV_{max}$ and the filter 0·5 mm copper plus 1·0 mm aluminium amounts 0·96 mm Cu. With a tube current of 10 mA dosage intensity at 50 cm distance is then 20 r/min.

# PHOTOGRAPHY 77

771.53 : 539.27

**An electron microscope study of photographic plate surfaces.** *See Abstr.* 5337

771.535 : 539.185.08

**The measurement of intense slow neutron fluxes by the photographic method.** *See Abstr.* 5315

778.3 : 537.534.75 : 539.164

**Range-energy relation for protons and alpha particles in photographic emulsions for nuclear research.** *See Abstr.* 5226

778.33 : 539.185.08

**Photographic methods of measuring neutrons.** *See Abstr.* 5316–17

77

**5404. Streak photography.** I. Vigness and R. Nowak. *J. Appl. Phys.*, **21**, 445–8 (*May*, 1950).

Ordinary streak photography consists of pho graphing a moving object on a moving film cam with an open shutter. The motion of the obj should be in a plane parallel to the film and perp dicular to its motion. Large errors in veloc determinations may occur if the motion of the obj has components parallel to the film motion. modified method of streak photography is descrit in which these errors are reduced to small valu By this method time-displacement curves have be recorded for displacements of many inches a periods of several seconds with accuracies within few thousandths of an inch and a few hundr thousandths of a second.

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